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For Herbert John Fleure, F.R.S.

On his Eightieth Birthday, 6 June 1957

THE YEAR 1957 is a notable one in the life of Professor H. J. Fleure. On the 6th of June he celebrated his eightieth birthday, while it is fifty years ago to this very year that he first began to teach geography as a special subject at the University College of Wales, Aberystwyth, and exactly forty years since he was elected Secretary of the Geographical Association. Remarkably enough this same year is also the fortieth anniversary of his election as the first holder of the Gregynog Chair of Geography and Anthropology at his old College.

Most of us have been too closely connected with the development of our subject in the last half century to be able to assess it in its true perspective, but most will agree that these years have been the formative years in its history as an academic discipline in this country, and that the influence of Professor Fleure on its progress has been great indeed.

When he first began to lecture in geography at Aberystwyth the great work of Vidal de la Blache at the Sorbonne had already reached its zenith. One would have thought that H. J. Fleure, with his half-French background and his deep understanding of and admiration for France and her people, would have been the ideal person to have introduced into Britain the current ideas of this great school of French regional geographers. Curiously enough it was his great contemporaries Mackinder and Herbertson who attempted to do this, and subsequent events have shown that with all our efforts in Britain nothing has ever been produced in regional geography that is in any way comparable with the great French regional monographs of the early years of this century. Fleure, however, had other ideas. Even before his coming to Aberystwyth as a student he had come strongly under the influence of the Scientific Revolution of the mid-nineteenth century. He himself has written "I had begun my studies in isolation . . . trying to understand the thought of Darwin and had felt that I must get to a university and research into the idea of evolution as applied to humanity." Having begun on this task, and having equipped himself at Aberystwyth and Zürich as a scientifically trained zoologist and physical anthropologist, he quickly realized with Herbertson that man and his environment must stand together. There are no men apart from their environment. Here quite simply is the basis of Fleure's geographical teaching. So that he might understand the physical environment the better he equipped himself further as a geologist and a botanist. It is not surprising therefore, that before he became Professor of Geography and Anthropology he had taught botany, zoology and geology as well as geography at Aberystwyth. By to-day we are all conscious that our subject must of necessity carry us into the domain of other specialists, but there are few of us who now possess, as Fleure does, the necessary qualifications to enter into these fields and command the respect of the specialists concerned.

Furthermore, it would be a great mistake to think that the environment of man meant for Fleure only the physical environment, as one might have gathered from his specialist background. Social and historical factors were equally important. His interest in the Darwinian approach led him naturally to attempt an understanding of the evolution of man's thought throughout the ages and thereby an assessment of the vast cultural endowment modern man has inherited from the past. In this broad field he was never satisfied to consider only the periods for which written records exist. He sought to dig deeper into the past. The ruins of a Cistercian abbey, a Saxon church, a Roman trackway, an Iron Age camp, a Bronze Age axe, a megalithic tomb or a Palaeolithic cave painting were all seized upon with this end in view. In this way, too, Professor Fleure became a keen student of archaeology and, as is well known, he has made many important contributions in this field. The most recent is the final volume of *The Corridors of Time*, indicating a wealth of scientific knowledge and erudition truly remarkable for a man on the threshold of his eightieth birthday.

Considered in this way Fleure's geographical philosophy could hardly be contained within the limits set by the French school of regional geographers and his contributions, therefore, have been greatest in what it is now fashionable to call the systematic aspects of the subject. In greater detail these would include in Fleure's case the systematic disciplines on the human side, racial geography, historical geography and the geography of current affairs. Sometimes he approximates closely to the regional field but, even so, he makes it clear that his well-known book on Western Europe is "*Human* Geography in Western Europe" and not a "*Regional* Geography of Western Europe." Similarly in a famous paper in the *Scottish Geographical Magazine* he wrote about "Human Regions" and not "Natural Regions" as Herbertson would have done. It is said that when he suggested to the donors of the Aberystwyth chair that it should be entitled the Gregynog Chair of Geography and Anthropology, he had no intention of teaching these subjects as separate and independent disciplines for degree purposes (in fact, they never became so) but that he wished the Chair to be so named to indicate that it was to be a Chair of Human Geography in the widest sense of the term.

Such breath of outlook has been characteristic of Fleure's teaching. It allowed him, at an early stage, to emphasize several aspects of the subject which we now consider to be extremely important. To him geography was a bridge between the Arts and the Sciences. Most university teachers of geography to-day are happiest in either the

Arts or the Science Faculty, but it has been characteristic of Fleure from his student days to his eightieth birthday that he has been at home in both fields. The urgent need to strengthen this bridge to-day is clear to all. Fleure's broad vision of geography led also to his realization of the contribution it could make to the sympathetic understanding of other peoples and their problems in the international sphere. The need for strengthening this aspect of our work in the present political climate is equally clear. The breadth of outlook adopted by Professor Fleure allowed him to go even further than this. Like so many philosophers of the early part of this century he felt that the Darwinian revolution had shattered older ways of thinking. The static world in which man occupied the central position by divine ordinance no longer existed. Man was a part of nature and, like nature, in a process of continuous change. A new synthesis was needed to replace the old, and it was one of the goals of Professor Fleure's teaching that he believed that a new synthesis was possible and that underlying everything was the fundamental unity of nature. In this way his mind was always near to religious matters although he resolutely and consistently avoided the use of orthodox terminology. It was for this reason that he tried to help teachers and students alike to understand something of the geographical background of the Bible and of the distribution of the great religions of the world. Titles such as "Palestine: a lecture to teachers of scripture and geography to suggest co-operation and mutual aid"; "Roads and travel in Bible times"; "The geographical distribution of the major religions," appear frequently in the lists of his published works. Likewise, in his teaching he never missed an opportunity of using a Biblical quotation—a matter of much attraction to the Welsh undergraduates of his day. Even so, it must be remembered that there were few professors of geography (or, for that matter, professors of any other subject) who could quote from the Hebrew as well as from other Scriptures and apply the quotations at the same time to what was essentially a matter of biological adaptation to environment. The writer well remembers him lecturing on the geographical distribution of the lion, stressing its provenance on the fringes of the arid interiors of the Old World, and how, in the writings of Ancient China, we have a reference to its presence, in the sixth century before our era, in the Fen Hô valley, while at approximately the same period, but far away on the western fringes of Asia, the Second Book of Samuel records that one, Benaiah, killed "a lion in the midst of a pit in the time of snow." Neither did Professor Fleure miss the interesting reference to the snow—for even the Jordan rift-valley with its characteristic temperature inversions in winter might on rare occasions have snow lying on its otherwise semi-tropical floor. Here is the master craftsman at his work—the trained zoologist seeking the geographer's approach by emphasizing the importance of the physical environment in determining a zoological province, and illustrating his thesis by quotations from a wide range of ancient religious texts. This example summarizes much of what Professor Fleure stood for as a teacher of geography both as an art and a science.

It was as a teacher, in the true sense of the term, rather than as a university lecturer that he was at his very best. His teaching was always suggestive rather than factual. He dealt with research problems and did not present condensed summaries of existing knowledge, matter which could be easily obtained in print. For this reason his sentences frequently began with such phrases as "It would seem that . . .", "it is possible that . . .", "some think that . . ." or even "many think it probable that . . .". All this could be very stimulating for the good student. But Professor Fleure had patience with the weaker student too, in fact, with every one desirous of learning however limited their knowledge might be. Never did he mark down students of real quality for their limitations due to youth or lack of opportunity. His unfailing kindness and courtesy to all seekers after knowledge led him to make friendships with ordinary men and women outside our schools and universities, and in particular, with the quarrymen, miners and railwaymen of Wales. The widespread nature of his appeal as a teacher concerned not only extra-mural audiences but also his formal university lectures. In the early years at Aberystwyth it was not unusual to see members of staff and students from other departments and sometimes even members of the public attend his weekly 5 p.m. lectures which were delivered, in any case, to the entire Department of Geography. Such scenes are reminiscent of the lectures of the great Vidal de la Blache at the Sorbonne in his later years.

In looking back it is not only Professor Fleure's personal influence as a teacher of geography that we have to reckon with, but the influence of hundreds of his former pupils trained either at Aberystwyth or Manchester who are now grammar school teachers, training college lecturers, university lecturers and university professors. In this way his teaching has been passed on to many who never had the privilege of working with him in person. We take pleasure in the fact that one who stood at the beginning is still with us, fortunately able to see the fruits of his labours, in that the subject is now fully accepted alike in every primary school and university in the land.

The Geographical Association has bestowed upon him every office in its gift and he has been honoured by famous universities and learned societies, but most important of all is the fact that on his eightieth birthday we can offer him our personal salutations, and wish him and Mrs. Fleure (who has been his constant companion and helpmate from the early days at Aberystwyth) many more years of health and happiness to work for geography.

E. G. Bowen.

PRESENTATION TO
PROFESSOR H. J. FLEURE, D.Sc., F.R.S.

To mark the occasion of Professor Fleure's eightieth birthday, and the fortieth anniversary of his having taken office in the Geographical Association, a presentation was made on June 6th, 1957, of £270 together with a book of signatures from some 300 subscribers. Professor and Mrs. Fleure are taking a cruise to Norway prior to their attendance at the Third International Conference of Teachers of Geography at Grenoble, where Professor Fleure will lead the British delegation.

The following letter has been received from Professor Fleure.

Alice Garnett

My Dear Friends,

It is with a very full heart that I look through an album of your signatures and recall old times when we worked together, trying to understand mankind a little more fully as we learned. And those signatures accompany a large and generous gift that gives my wife and me the opportunity of a cruise in the Fjords of Norway. For all this kind thought and generosity please accept my very deeply felt thanks.

H. J. Fleure.

Air Mass Maps of China Proper and Manchuria

JEN-HU CHANG

SINCE THE PUBLICATION OF BERGERON'S PAPER in 1930,[1] the use of air mass as a method of describing and explaining regional climate has been increasingly adopted by both meteorologists and geographers. The primary purpose of air mass analysis is to make climatic patterns intelligible in terms of the general circulation and dynamic weather activities. The studies by Serra,[2] Borchert,[3] and Brunnschweiller[4] illustrate the geographic presentation of the modern meteorological idea of the Bergen School.

Maps of air mass distribution in China were first attempted by Gherzi in 1938.[5] In recent years, synoptic studies and aerological ascents have, however, provided new information that has made his maps outmoded and the construction of accurate and detailed maps possible. In this paper two new maps of air mass distribution in China Proper and Manchuria are presented and discussed. The boundaries on these maps are delineated by consulting the Historical Weather Maps,[6] mean streamline charts,[7] and the results of upper air soundings.[8, 9, 10, 11]

WINTER AIR MASSES

In winter the Mongolian anticyclone is well developed. From October to March the weather of the greater part of China is characterized by the intermittent outburst of polar air masses flowing out from this high pressure centre. The winter monsoon of greater strength than its summer counterpart distinguishes the climate of China from India where the monsoon influence is stronger in summer.

Fresh polar continental air masses (Pc) occur regularly only in Manchuria and the northwestern part of China Proper. The Pc air, with a temperature of about −10° C. and a specific humidity of less than 1 g./kg. at the ground surface, is remarkably stable. The weather associated with their occurrence is noted for the clear sky and severe cold.

The Pc air reaches China Proper mostly by land; it takes a maritime trajectory only when the Mongolian anticyclone moves eastward. In either case, the Pc air mass has undergone a marked degree of thermodynamic transformation en route. The modified air mass is designated either as land-transformed polar continental air mass (LNPc) or as sea-transformed polar continental air mass (SNPc).

➤ Dr. Chang is a research climatologist at Harvard University.

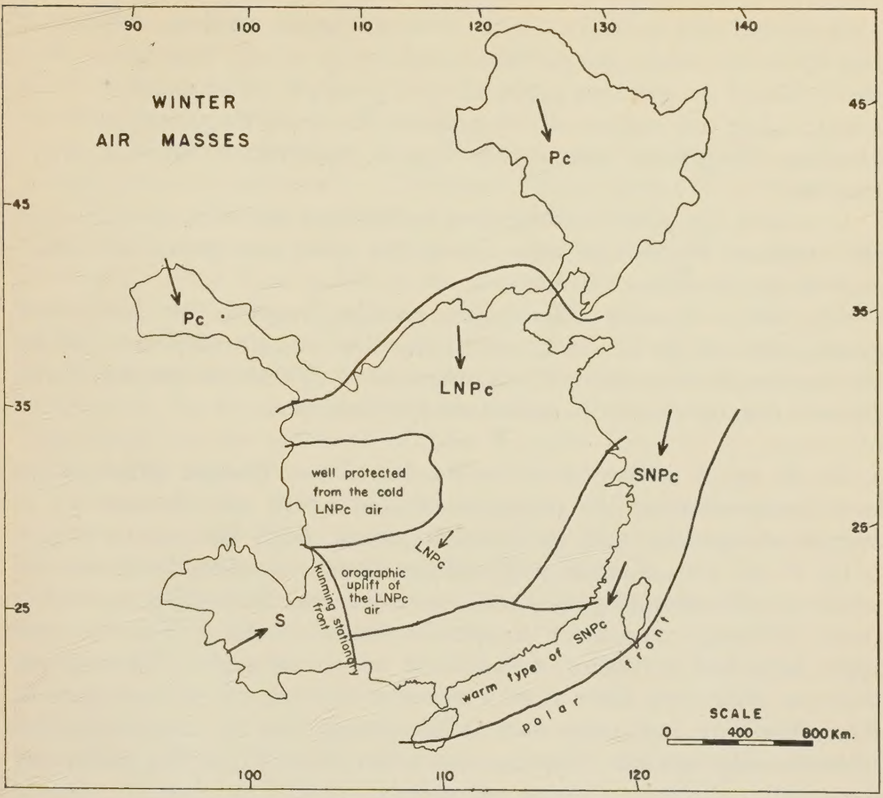

Fig. 1.

Although the LNPc air has received a considerable amount of heat and moisture in its southward journey, its moisture content is still rather low. The relative humidity seldom exceeds 50 per cent. Broken or scattered skies and moderate visibility attend its passage.

Due to its long maritime history the SNPc air changes from a cold dry stable condition to one of conditional instability with a marked increase in temperature and moisture content. Surface temperatures are well above freezing. Fine and mild weather prevails in lowlands, while in mountain areas orographic uplift of the air mass may lead to overcast and rainy weather.

The SNPc air mass gradually becomes more important and more persistent as one proceeds from northern to southern China. Heywood and Jefferies[11] found that in winter the SNPc air is the commonest air mass encountered over Hong Kong. They also noted the difference between the SNPc air masses that have travelled over the warm Kuro Shio and those that traverse only the relatively cold marginal seas between China and Japan. The surface temperature of the warm SNPc air is about 21° C., nearly 5° C. warmer than that of the cold SNPc. The warm type of the SNPc air has not been observed in central China.

In central and southern China it often happens that the LNPc and the SNPc air come into contact with each other. The fronts that result have a 41 per cent probability of producing bad weather.[10] Lu asserted that this surface of discontinuity lies most frequently over the Nanling Mountains where the rugged topography favours cyclogenesis.[12]

In winter the polar front or the contact zone between the NPc and the maritime tropical air mass lies off the coast and exerts little influence on the weather of China.

The lofty Tsinling Mountains greatly impede the southward propagation of the Pc air masses; those that occasionally come across the mountains are warmed by compression. Therefore the Szechwan Basin is immune from the incursion of cold waves.

To the south of Szechwan lies the Kweichow Plateau which is less well protected from the incursion of cold LNPc air. Because of its rugged topography and its location remote from the source region of the Pc air, the cold front in Kweichow usually assumes the characteristics of a quasi-stationary front, known as the Kunming stationary front.[13] Precipitation from the quasi-stationary front is of warm front type, light but persistent, and falling mostly at night. Throughout the year there are more than 175 rainy days in the greater part of Kweichow (e.g., 199 rainy days at Kweiyang), but the annual precipitation is only 130 cm. The mean position of the Kunming stationary front is actually located some 150 miles north of Kunming, the capital of Yunnan Province. Only rarely does the front enter into Yunnan Province.

In Yunnan the prevailing southwesterly in winter is regarded as a Superior air mass (S). The Superior air is the anti-trade of the subtropics that is heated by compression when it comes down from Tibet. The Superior air mass has a temperature of over 10° C. and a relative humidity of 20–30 per cent on the ground surface. It usually brings with it blue, clear skies. Night radiation and daytime insolation are very strong and these result in large diurnal variation of temperature. The influence of the Superior air is most profound in Yunnan and becomes weakened in Kweichow. Over the lowlands of China the Superior air occurs only as strong westerly currents blowing at a height of more than 4,000 metres above sea level. They have been identified in the upper atmosphere over Hong Kong throughout the winter from October to May.

FRONTOGENESIS IN SPRING AND SUMMER

In spring the southeastern Monsoon begins to blow and pushes the polar front northward. By the end of April southern China is completely under the domination of the summer monsoon. In May and June the front lies over the Yangtze Basin and in the height of summer it reaches northern China and Manchuria. This northward displacement of the polar front is accompanied by a simultaneous regional shift of the maximum precipitation which is produced by the battle of air masses in their zone of contact.

In April when the polar front lies over the Nanling Mountains it usually becomes stationary. The cloud deck is laterally extensive and light rain may fall for a period of more than a week.

In late spring and early summer the propagation of the cold front in central China is retarded in the west by the southwestern plateau and in the east by the rugged topography of the hills. As a consequence of this situation the polar front often takes a tongue-shaped form. Such orographic deformation facilitates the development of cyclonic vortices on the dynamically unstable waves. Yao has stressed that the Lake Basin to the south of Middle Yangtze River is an important cyclogenetic region,[14] while Sung has found that in China the peak of cyclonic activity is reached in late spring.[15] The prolonged frontal rainfall in central China during late spring and early summer, when the plum is ripening, is known as plum rain or *mai-u*.

Synoptically, the exact position of the polar front is determined by the strength of the summer monsoon. When the monsoon blows strongly in early summer the front will be pushed northward, lying over the Lower Yellow River Basin. Under such conditions northern China will receive abundant rainfall while the plum rain will cease in central China. Conversely, if the summer monsoon is weak and the front lingers over the Yangtze Basin, then northern China will experience a dry spell and central China a wet one. This fact confirms the view that the summer monsoon merely supplies moisture but does not by itself yield precipitation unless it encounters an uplift, either frontal or orographic.

SUMMER AIR MASSES

The summer monsoon in China consists of three air masses: tropical-Indian maritime (TI), tropical-Pacific (Tp) and equatorial maritime (Em). Of these three the tropical-Indian maritime air mass is least important. It comes from the Bay of Bengal as a southwesterly wind, penetrating as far east as 110° E via Burma, Thailand, and Indo-China. Since the TI air has to climb over high mountains before reaching the southwestern plateau of China, it has lost part of its moisture and its surface temperature rarely exceeds 25° C. However, the vertical distribution of moisture and temperature in the TI air is still favourable for convection. Local afternoon thunderstorms are not infrequently associated with its occurrence. In eastern Yunnan there are about 40 thunderstorm days in the summer.

With the exception of the intermittent incursion of the TI air the predominant summer air mass in Yunnan is still the Superior air. The dominant influence of one and the same air mass throughout the year results in a climate of "eternal sunny spring" in Yunnan. For more than 310 days in a year the daily temperature at Kunming lies between 10° and 22° C.

The Tp air has its source region in the Pacific high pressure centre; it is actually the northeast trade wind turned into a southerly wind in response to the summer pressure pattern of East Asia. At the ground surface the temperature of the Tp air is about 30° C. and the relative humidity 80 per cent. The air is conditionally unstable and requires an uplift of only 500 metres to reach its condensation level.

The Em air mass is the trade wind of the southern hemisphere that has crossed the equator, coming under the influence of a Coriolis force of opposite sign from that of its place of origin, thus acquiring a west component. In Southeast Asia these westerlies may be regarded as part of the system of basic zonal currents. Their depth is by no means shallow; Deppermann found that close to the equator they reach a height of more than 4,000 metres.[16]

In the lower strata of the atmosphere the physical properties of the Em air differ only slightly from that of the Tp air, but at higher levels the former has a higher potential temperature and specific humidity. The Em air is oppressive and uncomfortable, testimony to its instability being the heavy cumulus and cumulonimbus clouds. Showers occur frequently, especially when the Em air climbs over the Tp air.

To the south of Nanling Mountains the Em air is the predominant air mass in summer; to the north the Tp air is more important. The Hwai River may be regarded as the northern limit of the Em air mass, although on rare occasions it can reach the lower Yellow River Basin.

The landward limit of the prevailing summer monsoon is the mountain rim of the Great Khingan Mountains, Tai-hang Mountains, Tsinling Mountains, and Great Snow Mountains, where there is a concentration of isotherms in July. Within the bounds of Monsoon China the only air mass that is not tropical in origin is the polar maritime air mass (mP), coming from the Sea of Okhotsk. The mP air rarely appears in China Proper. In Manchuria it challenges the reign of the Tp air mass. It is moist in the lower levels and has a thin layer of convective instability. The low temperature and the cumulus or cumulonimbus type of weather attending its presence are indeed a comfortable relief from hot weather under the Tp air.

The high plateaus of northwestern China are not regularly benefited by visits of the summer monsoon, although it has been observed that even in Outer Mongolia the meagre rainfall is mostly derived from the rare penetration of the summer monsoon. Dry continental air (C) is the predominant summer air mass in northwestern China. Weather conditions are essentially those of high temperatures and a lack of condensation forms. The dryness of the continental air favours

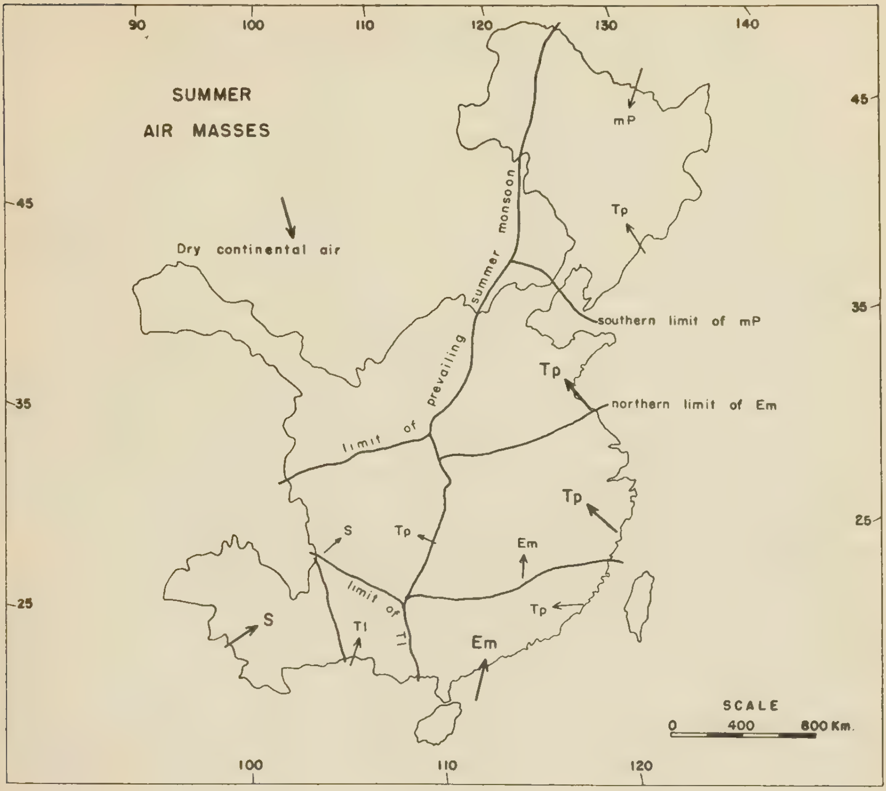

Fig. 2

strong radiation by night and insolation by day. The diurnal surface temperature change usually amounts to more than 15° C.

THE TRANSITION FROM SUMMER MONSOON TO WINTER MONSOON

The autumn transition of the monsoon regimes takes place much more rapidly than the spring one. The summer monsoon retreats from Manchuria and northern China in late August. In September the polar front vacillates in central China and by the end of October China is free from the summer monsoon. The polar front in its southward advance is often retarded by rugged topography, thus giving many mountain areas a slight rainfall maximum in early autumn (e.g., eastern part of Szechwan).

In autumn the NPc air regains its strength. Fine and mild, the weather in autumn is less subject to change than in any other season. In the greater part of China this is the most pleasant time of the year.

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The Nation's Water Supply

W. G. V. BALCHIN

"*All the rivers run into the sea; yet the sea is not full: unto the place from whence the rivers come thither they return again*" (Ecclesiastes 1. 7).

ALL WATER MOVES IN A HYDROLOGICAL CYCLE. Precipitation in the form of rain, or melted hail or snow, is absorbed by the soil of the earth and retained as ground water, or forms streams on the surface whence it is collected into lakes and oceans. Evaporation from lakes and oceans is supplemented by the moisture transpired by plants, and by the process of condensation rain is again formed and the cycle completed. The movement of water across the surface of the ground in response to gravity is usually spoken of as run-off; the movement into the ground is referred to as either infiltration or percolation, and off the ground as evaporation.

The cyclic movement of the water is thus continuous, but so far as man is concerned the supply and availability of water at any point in the cycle is by no means certain. There are many variations and great inconvenience arises by an absence or over-abundance of water. The conservation of water therefore becomes of importance whenever extremes are normally experienced, or when the demand for water by a growing community begins to exceed the minimum supply available. There is mounting evidence that we are rapidly approaching a time when the latter situation will arise in Great Britain. In a traditionally wet climate this statement frequently occasions surprise: few realize the enormous quantities of water needed to maintain our industrial existence and standard of living. There is an increasing need to regard water as a prime natural resource basic to our existence, and to work for its conservation and proper use.

If the cycle is studied it will be seen that any control or manipulation which man can exert must take place very largely in the stages of run-off and percolation. We are still a long way from any effective control of either precipitation or evaporation. Nature's temporary storage of water in lakes can be imitated by the construction of artificial overground reservoirs and these can function as flood control units as well as water storage units but they are dependent on precipitation for their contents. Man can also utilize nature's sub-surface reservoirs of ground water and is beginning to learn how to offset periods of deficiency by recharging them in times of plenty.

THE NEED FOR WATER

An organized society needs water for a wide variety of uses and in a broad survey we may divide these into about six major categories.

➤ Professor W. G. V. Balchin, who is Head of the Department of Geography at University College, Swansea, delivered his lecture on 1st January, 1957, to the Annual Conference of the Association.

The uses sometimes overlap, sometimes supplement and sometimes interfere with each other; but in all cases water is vital to the society.

Water for domestic purposes. This need for water will probably spring to the minds of most people in the first instance, for water is basic to health, personal well-being and personal cleanliness; and the more highly civilized the community the greater its dependence on, and its consumption of water. Cooking, drinking, cleanliness, sanitation, fire control, watering of gardens, etc. involve a daily consumption of some 40–50 gallons per head in Great Britain.

Satisfactory household water must not only be adequate in amount, it must be clear, free from harmful bacteria, odourless and 'soft' (free from excess calcium and magnesium salts), and it must also have "life" and not be "flat".

Water for the transportation of waste. Flowing water is vital to an organized community as a means of disposing of much of its waste matter, both by transport and by proper oxidation and dilution of the material. It is not perhaps as fully realized as it should be that most manufacturing and processing industries, especially those dealing with food, animal products, chemicals and minerals, along with sewered communities, must have water outlets for waste. This immediately raises the problem of pollution of the water downstream from the point of entry of the offending effluent. Increasing industrialization and a growing population inevitably aggravate the problem but it is not insoluble. Pollution can be prevented or controlled at a price and if the community insists. The steadier the flow in the stream, however, the easier is the task of maintaining purity: herein lies the importance of flood control and water conservation.

Water for industrial purposes. To some extent this category overlaps with the preceding category as water is commonly used in the manufacture and processing of ores, textiles, chemicals, pulps, foods, beverages, etc. Some industries however are exceptionally heavy users of water and this factor may determine their location. The biggest user of water is the electrical supply industry which needs upwards of 15,000 million gallons a day. Expressed in another way a coal-burning power station needs 600 tons of water for every ton of coal consumed. Atomic power stations will probably need even more. The iron and steel industry is another heavy consumer—it takes 18,000 gallons to make a one-ton iron ingot and another 65,000 gallons to turn the iron into steel, i.e. about one hundred tons of water are needed for each ton of steel produced. All told the industry needs upwards of 350 million gallons a day. But this is eclipsed by the chemical industry which now takes 820 million gallons a day and will probably need 1,200 million gallons a day by 1966.

A large oil refinery needs 60,000 gallons of pure water every hour and in the same period 3 or 4 million gallons of second-grade water for cooling purposes. Paper production similarly involves the use of exceptional water supplies—a ton of paper needs 100 tons of water in its manufacture, and the industry at present consumes about 200 million gallons daily. Plastics require up to 30 tons of water for each ton produced.

Some activities involve a water consumption much greater than is commonly realized. The Flying Scotsman uses 10,000 gallons in a single journey: locomotives in Edinburgh draw a million gallons daily from the mains. The production of a car needs 200,000 gallons of water. These examples which could be multiplied many times serve to emphasize the importance of water in industry in which field there has been such a dramatic rise in consumption in the last few decades. This rise is likely to continue with the introduction of the principle of automation and the continuous flow techniques of the chemical engineer. The only relief lies in the fact that much of this water can be re-used and re-cycling is becoming increasingly common, also the water need not always be potable or pure. But industry in Great Britain has in the past depended to a large extent on local authorities for its water supply, and the latter are fundamentally concerned with potable water for domestic purposes. The larger industrial concerns of the future may find it necessary to be responsible for their own water arrangements and will doubtless increasingly turn to second-grade supplies, especially where cooling processes are involved.

Water for agriculture. Food cannot be produced without water and here again much more is needed than is commonly realized. Counting the water necessary to produce the crops consumed as well as the amount taken directly by the animal it will be a surprise to many to learn that one pound of beef has needed 30 tons of water for its production. Vegetables are 80–90 per cent water; milk is 87 per cent water; a bullock needs 10 gallons a day. The whole farm economy is clearly dependent on the availability of adequate supplies of water. It is only during the present century that piped water has begun to reach farming communities in Great Britain and a great deal still remains to be done in rural areas. As the network expands so consumption increases and at the same time new ideas increase the actual and potential demand.

The greatest increase in the more immediate future is likely to arise from the spread of summer irrigation in Great Britain. This is another paradoxical situation in our traditionally wet climate. The knowledge gained by irrigation experts in semi-arid and arid regions of the world is now, however, being applied to humid areas with pronounced success. Basically one tries to supply deficiencies of water to ensure maximum crop production and, in our variable and unreliable climate, irrigation can be usefully applied at some time of the growing season almost every year. Potatoes, root crops and grass benefit most from controlled irrigation. Careful water management will increase a potato yield by two tons an acre, whilst irrigated grass pastures enable the maximum head of stock to be carried. Sprinkling systems are already appearing in southeast England and will become increasingly familiar in future. But the prospective demand on the water supply is phenomenal: if the agricultural land, excluding the cereals, were fully irrigated in a dry year some two million million gallons (i.e. about three times the total amount now being supplied by all combined water undertakings) would be needed.

Water for power. Power from flowing water has had an interesting development. The first mills were located on streams and falling water provided the motive power. Later the development of the steam engine caused a shift on to the coalfields. Next came the development of electric power which could be produced either by hydro-electric methods or by coal via high-pressure steam plants. In either case water in large quantities again became necessary and this is one of the most important features in both locating and determining the output of an electric power station.

Effective hydro-electric power stations in Great Britain are limited to parts of Scotland and Wales; but thermal electric power stations are found throughout the land and are usually located where coal can be easily delivered to the site, and where adequate supplies of water are available for steam-raising and cooling purposes. Atomic power stations similarly need large quantities of water. The location of all these projects becomes increasingly difficult as available supplies of water diminish. The greater re-use of water and the use of sea water will become more important.

Water for transportation and recreation. The use of rivers and canals for transportation is not now so important as in the past. Nevertheless in terms of tonnage carried, large quantities of goods are moved in Great Britain during any one year by water transport, a use for water which must not be overlooked in any conservation plans. Similarly it is difficult to imagine any completely satisfactory mental and spiritual outdoor recreation without water in the picture. Whatever the pursuit, whether to look at, swim in, sail on, fish in, or for the opportunities of skating, skiing and tobogganing, water is necessary in quantity. Conservation for recreational uses must also be considered.

From this brief examination of the possible major uses of water, it is clear that the uses overlap, supplement and sometimes interfere with each other. Transportation of waste precludes recreational use. Power production may impede navigation. A reservoir on the other hand may create recreational facilities, but in all cases the conservation of the available supplies of water is desirable for the continuance of the use by the maintenance of a steady flow.

THE DEVELOPMENT OF THE WATER SUPPLY ORGANIZATION IN GREAT BRITAIN

The earliest inhabitants of these islands were for long dependent on natural water supplies from springs, rivers and lakes—the availability of water was often the key factor in the determination of settlement sites—the Anglo-Saxon nucleated villages placed along spring lines in southeast England are notable examples. As a settlement grew in size it became desirable to organize the supply of water. Hull has a water charter dating back to 1447; Plymouth's first water Act dates from 1585 and was in fact a civil venture promoted by Sir Francis Drake. London's New River project dates from 1613.

The movement, however, was slow to spread and it was not until the sudden expansion of towns with the industrial revolution that the problem of water supply became acute. This was partly because the needs of increasing population outgrew local supplies, and partly because the fear of cholera led to the sanitary idea becoming dominant in local government. The Royal Commission of 1844 recommended that local authorities should have definite responsibilities for water supplies as well as drainage. The provision of a town's water was now taken up afresh although it was not until the Public Health Acts of 1872–78 that the duty was laid upon sanitary authorities to secure the provision of wholesome and sufficient water for the needs of their areas. Water supply thus ranks as the oldest of our public utilities and this largely explains some of the present day difficulties. The existing system largely grew up when the administrative unit was the parish or town and long before the concept of conservation or any ideas of wider integration had evolved.

The latter years of the nineteenth century saw Parliament increasingly occupied with water bills for new undertakings. Some of the applications were from local authorities, some from private persons who had formed limited companies. Before long the number of individual companies had passed the four-figure mark and the greater part of the urban community had access to reasonable supplies of water. For many years local sources, which as we have seen originally determined the siting of local communities, sufficed for local needs. But the towns grew to cities and the improved availability of water led to increased consumption. Turning on a tap was not the same as drawing water from a distant well or spring. The larger urban units hence outgrew their local supplies and began to look elsewhere for water. Between 1879 and 1904, Manchester, Liverpool and Birmingham developed sources in the Lake District and Wales, some 106, 68 and 74 miles away respectively from the cities.

The piecemeal growth of the system continued and there was a considerable amount of competition between the companies in obtaining and supplying water. This led to a great deal of rivalry and a certain amount of wastage took place with the rather absurd situation of two companies occasionally laying pipes along the same routes. It was not until after the drought of 1921 that the first glimmerings of the need for a wider approach became noticeable. In 1924 the Ministry of Health encouraged the formation of Regional Advisory Water

Committees for certain areas. In 1927 the Water Pollution Research Board was set up as a result of the increasing pollution in many rivers which were being used as a source of water for the public supplies.

A new phase occurred in the 1930's. The period 1932–34 was marked by a series of dry winters and summers and an almost unprecedented drought occurred in 1934. A spate of Water Acts followed! The Rural Water Supplies Act 1934 was passed to stimulate the provision of water supplies to those rural localities which had hitherto been neglected. As a result districts where inhabitants are not within reasonable distance of a piped water supply have been reduced considerably. The Supply of Water in Bulk Act 1934 provided for the bulk supplies between water undertakings and marks a first step of balancing surpluses with deficiences and a more co-operative approach to the problem of water supply.

The drought also threw into relief a lack of information about our water resources. The Meteorological Office had adequate statistics of rainfall and the Geological Survey had collected details of underground resources. But little or nothing was known statistically of the surface waters in the British Isles. To offset this deficiency the Inland Water Survey was set up in 1935 to collect and correlate available records of surface waters. The old Advisory Committee on Water in the Ministry of Health was reconstituted in 1937 as the Central Advisory Water Committee, and this marks the first step towards the concept of conservation, since the Committee was concerned with water generally rather than with water supplies. In a series of reports the Committee dealt with underground water (1938), the planning of water resources and supplies (1938), Parliamentary and local aspects of water supply (1939), and the policy of River Boards (1943).

The effect of the drought of the early 1930's can therefore now be regarded as significant and beneficial in the development of the water supply organization. It led to a new attitude towards the problem and provoked an encouraging start towards conservation. Progress at the same rate has not alas been maintained since 1940. The outbreak of the war very quickly caused the suspension of the Inland Water Survey and many water schemes were postponed or abandoned.

New hopes were raised by an admirable Government White Paper in 1944 which formed the basis for the Water Act of 1945. The latter imposed upon the Minister of Health the duty, since transferred to the Minister of Housing and Local Government, "to promote the conservation and proper use of water resources and the provision of water supplies in England and Wales, and to secure the effective execution by water undertakers under his control and direction, of a national policy relating to water."

The necessary administrative organization to achieve this has, however, failed to emerge, and a disturbing number of setbacks have occurred in the post-war period. The Minister did not set up the

Regional Advisory Committees which the Water Act empowered him to appoint. The reconstituted Inland Water Survey began again after the war but was suspended as an economy measure in 1952. The Central Advisory Water Committee also lapsed in 1952, whilst the River Boards Act of 1948 set up boards responsible to the Minister of Agriculture. Many water supply schemes were thwarted by the lack of capital. Manchester's Haweswater reservoir was completed by 1941 but could not be used to alleviate the drought of 1949 as pipe lines had not then been laid. As recently as the 1st of May, 1956, the Minister of Housing and Local Government announced the postponement of 156 rural water schemes to the value of £5,800,000.

It is true that there has been progress in the amalgamation of some of the smaller companies but there still remain nearly 1,100 separate water undertakings in England and Wales responsible for providing public supplies. More than 900 are local authority organizations, just over 100 are water companies, 57 are water boards. Scotland has nearly 200 water undertakings. In addition to the public supply authorities there are innumerable private water developers—the City of London has over a hundred who draw considerable supplies from their own "wells."

THE RISING DEMAND FOR WATER

A review of the statistics of water supplied in recent years in most undertakings throughout the country reveals a steadily increasing consumption per day and also a rising consumption per head per day. It is now realized that if this continues without adequate preparations to meet the increase the country will face a grave water crisis in the near future.

With some 1,300 different undertakings in Great Britain it is difficult to present a completely accurate picture of the situation, but the trend can be clearly seen from a sample of 26 geographically representative undertakings (Table I). The population served by these undertakings is about 20 million or some 40 per cent of the total, and approximately half of the country's statistically recorded water consumption is covered by the table.

The table gives the consumption in million gallons per day (m.g.d.) and also the consumption in gallons per head per day (g.p.h.d.) for 1938, 1948, and 1955. With very few exceptions the upward trend is everywhere evident. In England and Wales the total quantity of water supplied by these undertakings rose from 651 m.g.d. in 1938 to 778 m.g.d. in 1948 and 856 m.g.d. in 1955—a fairly steady increase of about 12 m.g.d. per year. If the Metropolitan Water Board is excluded, as the position here appears to be temporarily static perhaps as a result of population dispersal, we see that the rise in the remaining 21 undertakings has been from 341 m.g.d. in 1938 to 444 m.g.d. in 1948 and on to 534 m.g.d. in 1955. The 1948 figure is 30 per cent, and the 1955 figure 56 per cent higher than in 1938, a rate of increase which implies that before 1970 many water undertakings will be faced with a demand for twice the amount of water consumed in 1938. The four sample undertakings from Scotland reveal the same upward trend from 121 m.g.d. in 1938, to 133 m.g.d. in 1948, rising to 148 m.g.d. in 1955: but the rate of increase is less than that of England and Wales.

We see the same upward trend in the consumption in gallons per head per day. In England and Wales the range varied in 1938 from 20·6 to 43·8 g.p.h.d. with an average of 32·3 g.p.h.d.: in 1948 it had become 27·3 to 68·0 g.p.h.d. with an average of 40·0 g.p.h.d.: and by 1955 the range was 29·0 to 94·0 g.p.h.d. with an average of 44·7 g.p.h.d.

Table I

Recent Trends in Water Consumption

	Consumption in Million Gallons per Day			*Consumption in Gallons per Head per Day*		
	1938	1948	1955	1938	1948	1955
England and Wales						
Manchester Corporation	50·4	62·5	74·2	41·0	52·8	58·0
Liverpool Corporation	39·9	45·7	52·1	37·2	45·5	48·0
Birmingham Corporation	36·0	44·0	52·6	31·8	37·3	42·0
South Staffs. Water Co.	25·0	33·9	38·6	24·3	29·2	36·0
Newcastle Gateshead Water Co.	24·9	28·6	33·9	37·2	42·7	47·4
Leeds Corporation	17·0	20·9	22·7	34·4	42·1	41·0
South Essex Water Co.	17·3	24·6	32·6	28·6	40·4	44·0
Bristol Waterworks Co.	15·9	18·9	25·5	34·7	40·4	47·0
Colne Valley Water Co.	14·3	20·4	23·2	34·1	37·0	40·0
Nottingham Corporation	13·6	18·5	21·5	29·0	38·3	41·0
Portsmouth Water Co.	11·3	14·0	18·4	37·9	47·0	46·0
Staff. Potteries Water Board	12·1	14·1	17·4	34·0	38·0	42·6
Sheffield Corporation	10·7	24·2	34·6	36·1	45·5	49·0
Southampton Corporation	9·5	13·5	14·8	31·9	43·7	47·6
Cardiff Corporation	8·9	11·7	14·3	33·5	43·4	47·0
Durham County Water Board	8·9	13·3	13·2	23·8	30·4	32·0
Sutton & District Water Co.	7·6	9·2	8·6	23·0	31·5	29·0
Wolverhampton Corporation	6·4	8·8	10·9	30·2	35·9	42·1
Southend Water Co.	5·0	6·7	8·1	20·6	27·3	31·5
Newport Corporation	4·3	8·3	11·4	42·0	68·0	94·0
Barnsley Corporation	2·0	2·6	5·0	24·2	31·7	29·0
Totals	341·0	444·4	533·6	—	—	—
Metropolitan Water Board	310·1	333·9	322·2	43·8	51·8	49·5
Totals: England and Wales	651·1	778·3	855·8	—	—	—
Scotland						
Glasgow	74·4	81·7	90·2	59·3	69·5	74·0
Edinburgh	27·9	30·6	34·3	53·8	55·4	58·6
Dundee	10·8	12·0	12·9	52·9	59·0	63·0
Aberdeen	8·4	9·2	10·2	46·5	47·7	53·0
Totals: Scotland	121·5	133·5	147·6	—	—	—
Combined Totals: England, Wales, Scotland	772·6	911·8	1003·4	—	—	—

In Scotland again there is the same tendency evident: in 1938 the range was 46·5 to 59·3 g.p.h.d. with an average of 53·1 g.p.h.d.: in 1948 this had become 47·7 to 69·5 g.p.h.d. with an average of 57·9 g.p.h.d.: and in 1955 this had further risen from 53·0 to 74·0 g.p.h.d. with an average of 62·1 g.p.h.d.

The g.p.h.d. figures reflect the rising standard of living throughout the country and in this connection it is well to bear in mind the experience of the United States in water consumption. Here, with a very much higher standard of living, averages of over 100 g.p.h.d. are common. To these figures we must add the unrecorded and in some cases much heavier consumption of industry, and recollect that in both industry and agriculture the same upward trend in consumption exists. It is clear that if our own standard of living is to continue to rise then the water industry must be prepared to meet formidable prospective demands in the immediate future.

WATER IN THE FUTURE

It has been demonstrated that the total amount of water now being consumed has been rising steadily during the past two decades. The rise is partly a result of the increased population and its rising standard of living, although it is probably in the industrial field that the most notable direct increases in consumption have occurred. We have noted that the consumption here is likely to go on rising and to this need we must add the prospect of extensive demands from agriculture.

The natural resources of the country in terms of rainfall are however adequate, and at first sight appear far more than adequate for any demands that are likely to be made. Estimates of averages of 2,000 gallons per head per day of the population have been given, and the amount available after evaporation is thought to be some fifteen times the total present consumption in the country as a whole. But the greater part returns very rapidly to the sea via direct run-off and the rivers. The construction of more roads and roofs in the urban areas and the activities of the land drainage engineer in rural areas accelerate this process and hurry the rainfall back to its source: the slightest interruption in the hydrological cycle is now rapidly reflected by diminished streams and diminished water supplies.

The total water supply in Great Britain may be adequate but it is of little use unless it is available in the right place at the right time. Nature has a habit of distributing the rainfall unevenly both in time and place, and if the local demand for water outgrows the local minimum supply the only way to escape from the dilemma presented by nature is to conserve supplies in reservoirs locally or at a distance in areas with surplus water. It is becoming apparent that the situation which the larger urban units faced at the end of the last century may shortly be reached by the country as a whole. With the present organization of the water industry we now have the prospect of a

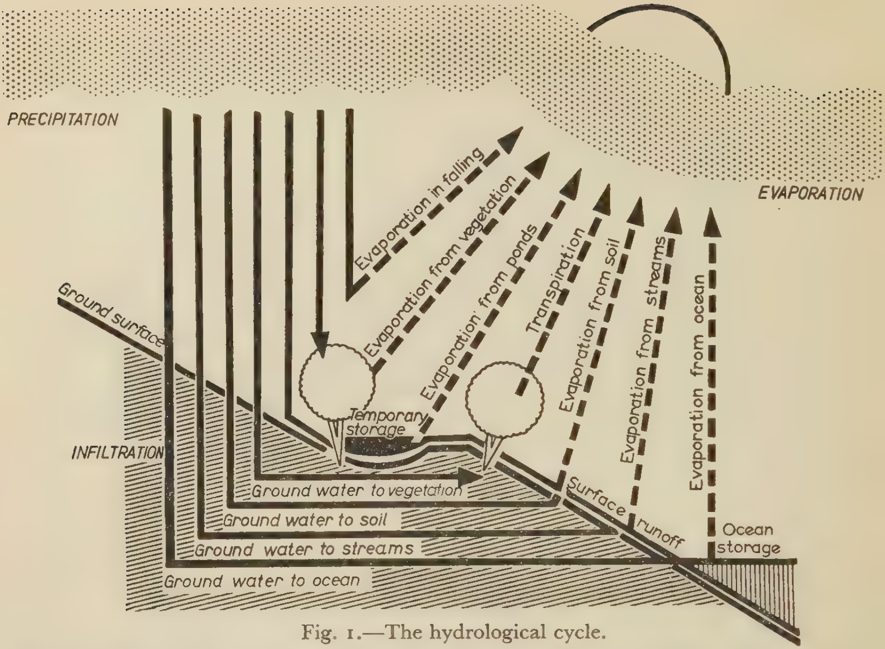

Fig. 1.—The hydrological cycle.

multiplicity of undertakings all seeking additional water outside their present areas and inevitably clashing with other interests. Conflicting cases are already rising. The Thames Conservancy Board for example is objecting to the activities of the Eastern Gas Board in the Dunstable area and to the work of the Banbury Corporation at Grimsbury. Liverpool is finding increasing opposition in attempting to secure additional water from North Wales. The North Devon Water Board is in difficulties with the Dartmoor National Park Committee.

A geographer looking at the water supply problem in relation to the country as a whole is inevitably struck by the lack of any central co-ordinating body for water. Water is our number one public utility: we cannot exist without it. We already have responsible bodies and long-term national plans for coal, gas, electricity, transport and afforestation and yet we have no such authority or plan for water upon which everything else depends!

It is true that good work is being done at present by the reconstituted Central Advisory Water Committee and Surface Water Survey responsible to the Minister of Housing and Local Government: by the River Boards responsible to the Minister of Agriculture: by the Water Pollution Research Board, the Hydraulics Research Board and the Geological Survey responsible to the Department of Scientific and Industrial Research: and by the Meteorological Office responsible to the Air Ministry.

But we need to know more about water deficiencies, moisture balance, liability to floods and droughts, whether afforestation is or is not detrimental to water supply, the effect of extensive irrigation, how to recharge underground sources artificially and on what basis compensation water should be organized. There are numerous problems within the water supply industry itself that need further study: such as methods of waste avoidance, recycling of water, use of sea water, the metering of supplies, the repurification of used water, problems of pollution and sewage disposal, the possibility of artificially induced precipitation and the control of evaporation.

There thus appears to be an urgent need for a Hydrological Research Board to study these and other related problems and to provide the basic information needed for the formulation of a national policy for water. Such a Board would have as its first duty the systematic collection of hydrological data, such that it became a storehouse of information on matters hydrological in much the same way as the Geological Survey functions for geology and the Meteorological Office for meteorology. It would then rapidly become a suitable national clearing house for all internal inter-departmental contacts, and external international contacts on hydrological matters. On the basis of the collected information it could begin to assess the country's water resources both over- and underground and future water needs; work out potential gathering grounds and reservoir sites; study regional water grid schemes; and investigate the possibility of flood control and hydro-electric power development as an integral part of a policy of water conservation. Much if not all of this data needs to be expressed cartographically for a correct appraisal of the situation. the geographer notices immediately the almost complete lack of any official maps dealing with the various parts of the hydrological cycle. A Hydrological Research Board would also hold a watching brief upon the position of water in the national economy and guidance would be given in the determination of priorities of possible developments in relation to the financial, technical and other resources available at any time.

Rising consumption in water, increasing pollution, falling water tables, diminishing resources and increased competition for the available land all suggest that the problem is urgent. We are prepared to plan ahead for the future in the case of coal, electricity, transport and forestry; why not for water?

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The Agricultural Geography of North Derbyshire

H. C. K. HENDERSON

THE DISTRIBUTION OF LAND USE in Derbyshire in the thirties was analysed in the Land Utilisation Survey's Memoir published in 1941,[1] and in that volume the distributions of the 'seventies and the 'forties of last century were summarized for Central Derbyshire. The general implication of the records of these three dates was shown to be a close affinity between the solid geology and the land use, and five main zones were recognized. Of these, the most southerly, developed in the Triassic rocks of the Trent lowlands, is outside our present area but it will be helpful to summarize the findings in the other regions:—

(1) The Carboniferous Limestone region, which consists of a plateau with general elevations of a thousand feet or more, proved to have been an area of livestock farming, with an emphasis at all dates on dairying. Cheese making was characteristic until the demand for fluid milk in London led the Express Dairy Company to establish a depot at Rowsley, some four miles north of Matlock, and the majority of farmers began to have their milk collected by the Company's lorries.

(2) The Millstone Grits with their interbedded shales bore little ploughland at any date on account of their exposure and the inferior acid soils which result in typical heather moor devoted to grouse shooting and sheep grazing. Where the Grits have developed scars as the result of erosion, one finds the shales offer shelves of clay soils with an admixture of downwashed coarse sand, and here are found narrow zones of improved land.

(3) The Coal Measures were found to have a fair proportion of arable land at all dates and were devoted to mixed farming, with dairying increasing in importance as the coal mining population increased. The distribution showed the Middle Measures to be more cultivated than the Lower Measures, probably due to the fact that there are more sandstone horizons and the soils are therefore less heavy.

(4) The Magnesian Limestone country along the eastern edge of the county is a cuesta with a westward facing scarp. Here the agriculture has been arable livestock farming and the area is a traditional sheep and barley region of high productivity.

➤ Dr. Henderson, who is senior lecturer in geography at Birkbeck College, University of London, read his paper at the Association's Spring Conference at Matlock, on 24th April, 1957.

Following this summary of the situation at the time of the Land Utilisation Survey, studied in the light of past records, it is possible to turn to the story of farming in Derbyshire during the last 25 years. The general trends in the county as a whole are indicated by the statistics in Table I, which is a continuation of that included in the Appendix to the Land Utilisation Report on Derbyshire.

Table I

Land Utilisation, Annual Acreages
(Statistics supplied by the Ministry of Agriculture and Fisheries)

			Permanent Pasture		
	Crops and Grass	*Arable*	*Hay*	*Not for Hay*	*Rough Grazing*
1939	433,149	68,870	114,778	249,501	70,992
1940	425,289	96,204	103,193	225,892	93,698
1941	424,483	127,315	90,190	206,978	96,078
1942	423,985	145,905	79,577	198,503	99,012
1943	423,073	162,042	69,033	191,998	107,298
1944	419,912	173,088	61,586	185,238	109,843
1945	416,381	169,260	62,395	184,726	111,041
1946	414,555	165,076	61,251	188,228	112,844
1947	414,222	157,551	68,873	186,892	113,418
1948	413,753	160,729	70,177	182,847	115,569
1949	412,674	156,465	68,748	187,461	113,655
1950	412,846	156,653	69,843	186,350	111,324
1951	412,091	149,433	74,712	187,946	111,232
1952	413,324	154,799	74,454	184,071	110,105
1953	414,932	155,511	73,833	184,927	109,220
1954	416,577	152,284	72,403	191,890	107,018

The acreages of arable land today are still more than double those of 1939 though the peak of 173,088 in 1944 was some 20,000 acres in excess of the post-war average. In only one year since 1942 has the total fallen below 150,000 acres. Correspondingly, the area returned as permanent pasture declined during the war period but has recovered slightly since. The 1954 returns for meadow land (permanent pasture for hay) were only about 65 per cent of the 1939 figure, while permanent pasture, not for hay, covers 76 per cent of the pre-war area.

Actual tillage increased from 54,000 acres to 132,000 acres at the height of the plough-up campaign and, despite a post-war decline, the 1954 return shows an increase of nearly 100 per cent. As a general rule, the acreages devoted to individual crops has increased considerably. The area under wheat doubled by 1944 but has since declined to about 30,000 acres, while oats acreage nearly trebled under war conditions and is still credited with twice its 1939 figure. Outstanding is the record for mixed corn with an increase from 252 acres in 1939 to 12,500 in 1954; this continuing increase is indicative of the farmers' appreciation of its feed value. The large expansion of potato growing during the war has been followed by a considerable recession yet the acreage is still double the 1939 figure, while a similar increase in vegetable production has been followed by a decrease to an acreage only some 30 per cent above the pre-war figure.

Table II

CROP ACREAGES AND NUMBERS OF LIVESTOCK IN DERBYSHIRE

	1939	1944	1954
Tillage	53,725	132,118	101,945
Wheat	19,321	37,713	29,593
Barley	1,118	3,495	4,874
Oats	13,861	42,454	26,009
Mixed Corn	252	5,832	12,554
Potatoes	2,714	10,498	5,840
Turnips	3,730	7,013	3,839
Mangolds	3,852	6,641	4,350
Cabbage, Kale, etc. (Feed)	2,235	4,578	5,696
Vegetables	1,495	2,759	1,911
Cows and Heifers-in-milk	69,641	70,380	72,910
Total Cattle	168,240	183,413	190,817
Sheep and Lambs	147,848	105,758	123,109
Pigs	40,313	19,779	65,655
Poultry	1,004,187	570,953	1,083,651

The livestock figures reflect the war-time policy of the Ministry of Agriculture in the marked decline of sheep, pigs and poultry, but the post-war period has shown a large increase in the number of pigs, a re-establishment of the poultry side of the industry, and an increase in sheep which fails to make good the war-time decrease. Cattle figures show a steady increase throughout the period, more especially in categories other than dairy cattle.

The story of this post-war era is therefore one largely of stability at a level well above that of the inter-war years. The maintenance of this position has been achieved by government action. By subsidies on products, by grants for ploughing land which has been untilled for some time, and by grants towards the cost of reclamation of marginal land and hill pasture, farmers have been encouraged to keep land in tillage and to improve some areas which had been uncultivated hitherto or at least for a long period. In addition, grants have been made available towards the repair or reconstruction of ill-conditioned buildings. With some or all of these aids, the general standard of husbandry has been raised, and, on the better land, yields have increased.

A survey of samples in each of the regions described above will help to emphasize the nature and degree of the changes of the past fifteen years. Firstly, on the Carboniferous Limestone plateau, farmers are continuing to lime their pastures regularly, while some have found that potash dressings are necessary before good crops of clover can be ensured. Some farmers are investing as much as £2 per acre in artificial fertilizers. The well-established system of tilling for two or three years with oats (one or two years), cabbage and rape and possibly a few rows of potatoes, as a preliminary to re-seeding is still followed. Some farmers sow oats alone for two or three years before re-seeding. The process is usually so organized that only a small proportion of the farm is under the plough at one time and most bring all the pasture into tillage every fifteen years or so. This length of ley depends greatly upon the depth of soil and the site of the individual field. Ensilage has become a common feature in the area: a farm of 500 acres may well devote 80 acres to the production of silage, from green crops and grass, and 120 acres to baled hay, with about 40 acres under the plough.

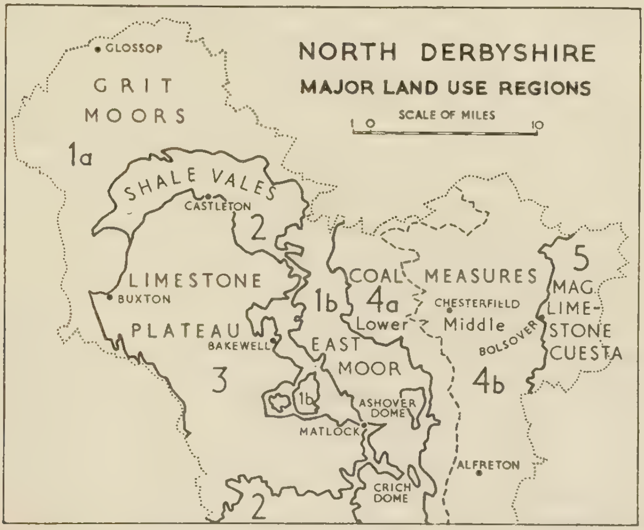

Fig. 1.—Key: 1a, Heather and peat moor. 1b, Heather moor with peripheral enclosures devoted to mixed farming. 2, Mainly pastoral; dairy cattle. 3, Long leys and dairying. 4a, Mixed farming with some arable land. 4b, Mixed farming with more arable land. 5, Intensively arable; sheep and barley.

The herds are mostly attested British Friesians but some farmers are becoming interested in changing over to Shorthorn crossbreds. In one case, near Newhaven, a herd of 40 Friesians is being replaced by a Hereford-Shorthorn herd. The Friesian herds, kept at upwards of 1,000 feet, give yields of about 1,000 gallons per annum, while heifers will average 750–800 gallons. These yields compare very favourably with those obtained in lower areas on the Limestone Shales; for example, in the Hope valley cows may give only 900 gallons and heifers 700 gallons.

The sheep are usually Kerry Hill or Clun ewes and average about 1·5 lambs per ewe, but are of less importance than the cattle. Poultry are kept by most farmers but few keep stocks of more than 100 birds.

Lastly, it is of interest that pioneer work is being carried out in this region. I have watched with great interest the creation of a farm on the moor above Longstone Edge. In the Land Utilisation Survey the area was all mapped as rough pasture and indeed some of it might have been included, justifiably, in the category of waste, for the lead mining of the past had left its mark. More recently, the old workings were re-opened for fluor-spar and nearby stood a cottage marked on the larger scale maps as " The Gamekeeper's Cottage." On my first visit after the war, there was improved land where heather used to grow—about 20 acres of it—and there were cows in milk pasturing, while on a further visit, three years ago, I was delighted to see that the enterprise was proving a success as there must have been a hundred or more cattle and a number of sheep (Swaledales). More recently, I have read of this venture,[2] and have learned that Mr. Wood, an ex-serviceman, had reached the hundred head of cattle in 1950, by which time, in six years, he had broken in 67 acres and was producing all the winter food he needed. By 1954, he had 132 cattle and 40 Swaledale ewes. One hesitates to estimate the change in land value of Longstone Moor Farm but, to those who knew the area in L.U.S. times, the present farmer well deserves the benefit of his labours and proves the value of the Hill Cattle Subsidy of which 60 per cent has to be devoted to reclamation and re-seeding.

Towards the east, the dales of the Carboniferous Limestone Shales give more clayey soils and are more easily maintained as pasture. These soils are usually under short leys of three to five years and while they are sown normally to oats and green crops, wheat is not unknown. In some cases, farmers have the benefit of downwash from the overlying Millstone Grits, as in the Derwent Valley or around the outliers at Stanton-in-Peak. Such areas carry rather more arable land, and the tillage is for a similar cropping to that of the limestone. Cattle are still the mainstay and farms of about 200 acres will usually carry 120 or more cattle and a flock of 30–40 sheep, again either Kerry Hill or Clun ewes.

On the Millstone Grits, the shale shelves above Matlock are consistently arable and mostly tilled, but the dip slopes of the Grits carry heather moor with some areas of peat. Hard labour and high skill prove capable of encroaching on this negative area, and improvements in earlier cultivated fields which had reverted to heather can often be seen. Particular examples are evident on the moors overlooking the Ashover basin. A long-established example of intensive use of Millstone Grit soils is to be found in the shrub and tree nurseries at Tansley. Further north, the grit country is higher and improvement is in the form of reclamation of some of the higher large rectangular fields of the later stages of enclosure and usually some distance down the dip slope, as in the neighbourhood of Wadshelf. In the extreme north, the grits are at too great an elevation for cultivation and such areas as Kinderscout remain heather and peat hag.

The general increase of the area under the plough is evident on the Coal Measures, but many farms have suffered from the war-time and post-war practice of working coal by opencast methods. On the eastern edge of the Ashover basin recent working is still very evident, but a more continuous belt of disturbed land runs just west of the road from Clay Cross to Pentrich, for here, at the base of the Middle Coal Measures* lie two seams of high quality, the Silkstone and the Yard, protected by the basal sandstone which is the scarp former on which the road is built. This scarp face had been covered by poor grass and gorse for many years, but a number of farmers improved it during the war, only to have it requisitioned later. One of the big problems of this development is the delay in restoring drainage while the soil settles. A more severe problem is met where sandstones are removed in the overburden, as these cannot be replaced and packed as nature packed them, and pore spaces must occur. Into these pore spaces top soil gradually washes and is lost to the crops—the results of such a process can be seen in many fields in the shape of large pieces of rock, large enough to be used as gate posts, lying on the surface of the fields. Farmers complain also of "tackle," such as wire rope, working up through the top soil and interfering with tillage. One farmer in the Erewash Valley area tells of bad drainage for nine years after restoration, another of poor crops with yields of 24–30 bushels of oats to the acre and only green crops such as a mixture of timothy and meadow fescue being successful. The net result is a tendency in this area to establish leys and develop dairying with attested Friesian herds.

Further north, both on the Lower and the Middle Coal Measures dairying is predominant and the staple cash crops are wheat and potatoes, usually grown on the sandier soils, which are associated with the higher relief resulting from the intercalated sandstones. Ensilage has greatly increased on coalfield farms and crops of winter beans and oats are frequently conserved in this way. The practice of sowing for short leys is increasing in a rotation with oats, wheat, roots, and oats undersown.

A number of farms on the Coal Measures had been neglected for many years when war broke out, and only the opportunity offered by the several government schemes have enabled restoration of land and buildings. Hedgerows had been neglected and had ceased to function as field boundaries. In areas which have been worked for opencast coal these have been replaced by wire fences, and elsewhere fencing has been used to fill the gaps. Derelict farmhouses have been restored and old barns have been rendered fit for cow stalls. On many parts of the Coal Measures the shales yield cold wet clays which provide good grass but which necessitate keeping the cattle indoors for four or five months of the year; hence the need for good housing for the stock. Milk yields from the T.T. Friesian herds, common in the area, average 1,000 gallons per annum.

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* In the new mapping of the Coal Measures (e.g., Sheet 100, Sheffield) following recent geological survey, the division between the Lower and Middle Coal Measures is placed higher, at the Clay Cross Marine Band, lying a little to the east of Stretton Edge, which is the feature referred to here.

Lastly, one should mention the intensive cultivation of small areas for market gardening, nurseries and allotments. An example is the holding of about three acres at the western end of Tibshelf, where two brothers have specialized in the cultivation of chrysanthemums. Their business has evolved from their father's interest in growing vegetables and flowers. The absence of the old specialization in this district of the cultivation of camomile may be noted, as Farey reports some 200 acres in the early part of the last century.[3] The needs of modern London druggists are satisfied from Belgium.

On the Magnesian Limestone, the soils and the husbandry have always ranked high among the agricultural regions of England, and the traditional sheep and barley system of farming remains. At the same time, dairying has been adopted by many farmers and cash crops of wheat and potatoes are common. A number of farms have a six-course rotation on the basis of a grain, a two-year ley, a grain, roots (folded by sheep) and a grain. Frequently, the green crops are strip-grazed with the aid of electric fencing. Occasional market gardening holdings are found in association with the newer colliery villages and one particularly good holding of some 30 acres is located to the east of Bolsover.

In short, one must conclude by noting the general improvement in standards of husbandry and of yields of crops that is common to all the regions delineated in the opening summary. The general position is one of an intensification which provides a resuscitation of earlier distributions of arable land, but with an increasing influence on dairying and a change of emphasis from cheese to fluid milk in the Carboniferous Limestone region.

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Some Observations on the Geographical Significance of Slopes

D. R. MACGREGOR

SLOPE IS ONE OF THE MOST IMPORTANT ELEMENTS in any landscape. Height and colour will frequently make more immediate impacts upon the eye, but the most accurate and lasting impressions are of landscapes whose slopes have been registered clearly, albeit sometimes unconsciously, in the mind. Furthermore, slope is of interest not only to the physical geographer who is accustomed to make careful note of it, but to all field workers since in a multitude of ways it conditions drainage, soil, vegetation and the works of man.

The attention given to the study of slope is, however, too often inadequate, and in school and first year university classes there is perhaps too much preoccupation with altitude. Slopes are referred to rather vaguely in terms such as "fairly steep," "rather flat," etc.; no precise meaning is attached to the terms employed, and they are used in various contexts and with consequent variations in angular value—steepness in the motorist's sense for example is not synonymous with the railway engineer's conception of it. It is unfortunate too that vagueness in terminology is conducive to careless observation—a cardinal sin in the study of geography.

It is the object therefore of this paper to examine different degrees of slope, to discover something of their influence, and to suggest how they may be described. At the same time some comments will be made on the appearance of slopes as seen under different conditions and from different viewpoints, and finally the interpretation of slopes from contour maps will also be considered: if various contour spacings can be readily translated into terms of slope, a map in truth assumes a third dimension and is consequently infused with new life and meaning.

An eye for slopes can be developed only through systematic practice in field observation, and this should begin as soon as the student has an elementary grasp of angular values. Slopes should be studied, assessed and then checked for inclination by clinometer, and during such practice the student must learn to retain a visual impression of different angles of slope (Fig. 1). This is not altogether a simple matter for the beginner will find that slopes are deceptive features

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often appearing to be steeper than is actually the case. Even an experienced geographer may be misled since the eye becomes easily accustomed to the "slopes" of published diagrams which are necessarily always exaggerated.

The most common view of any feature is the frontal view which despite its apparent command frequently presents an effect of exaggerated steepness. This occurs primarily because the dimension of depth cannot be easily measured and in bad light the deception is naturally increased: the third dimension is also very difficult to assess on a mountain side that ascends by an irregular succession of near vertical faces. The dimensions of height and breadth can act in various ways to affect an impression of slope: where the framework has a restricting effect as in the case of tall houses bordering a narrow street, the slope appears steeper than is the case, whereas the reverse is true of a wide avenue bordered by spacious gardens (see Fig. 2). In the one case the eye is drawn to concentrate upon height and in the other upon width, but the careful observer will strive to measure truly the distance in depth.

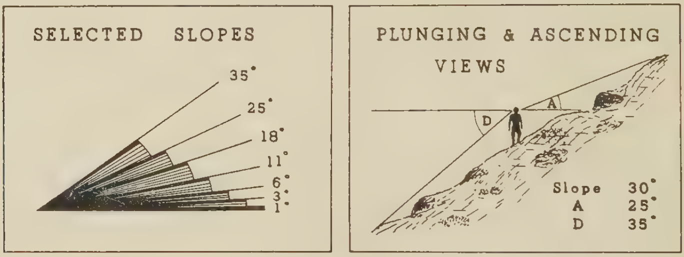

Fig. 1.

A plunging view is generally impressive, sometimes indeed to the point of being dangerous, and it is useful to try to analyse its effects. On a uniform slope, the descent is bound to appear steeper than the ascent on account of the observer's height (the angle of declination of the line of sight being greater than the angle of inclination, see Fig. 1). Secondly a plunging view is that to which the average person is least accustomed, in addition to which the eye is required to accommodate itself rapidly to considerable alterations of range. And thirdly the lesser visibility from above of steps and breaks of slope tends to build up the impression of a sweeping, unbroken descent while the view upward catches rock faces and shadows that indicate breaks of slope.

Oblique views of slopes are not liable to be so misleading as frontal views because the dimension of depth is partially measurable, but care must be taken in appreciating the form lines that dominate the scene. Steep slopes may be crossed by oblique lines and shadows that reduce the impression of steepness (Fig. 3), successive crest lines more than structural lines contributing to this effect. In like manner skylines and spurs should be carefully examined, for the visible crest often lies obliquely to the observer and is flanked by steep declivities that are not always readily visible.

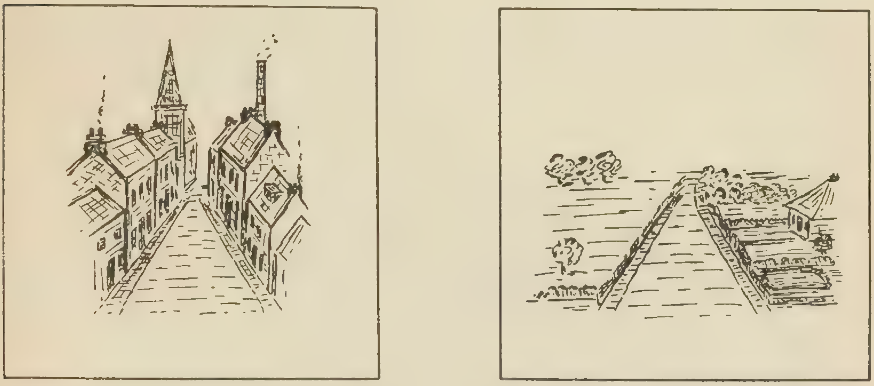

Fig. 2.—Since two views such as those above would never be seen simultaneously, they should be studied separately; therefore keep one sketch covered while examining the other.

Irrespective of viewpoint cloud and atmospheric conditions have interesting effects upon the appearance of slopes. The presence of low cloud at once gives an impression of increased height, and the inevitable accompanying dull light masks the detail in depth and exaggerates the vertical and horizontal dimensions. Oddly enough too, at a range of more than a mile, the ultra-clear visibility associated frequently with a humid and mild atmosphere in western Britain can be somewhat misleading, for the atmosphere operates as a pseudo-magnifying agent rendering difficult a true appreciation of depth. In fine weather with a clear sky and some haze, crest features appear to recede in depth and slopes consequently appear less steep.

Although slopes range through an angular arc of 90°, certain particular inclinations can be selected that are of especial geographical significance. These are presented here together with their equivalent gradients, notes regarding their individual significance, and terms suggested as suitable for general usage in the description of landforms. These angles are not to be regarded as rigidly precise for slight variations will be found according to different combinations of rock, soil and vegetation: they are, however, generally applicable to Great Britain and can be readily identified on the One-Inch O.S. map. (Observations on the relationships between streams and slopes are made in a separate paragraph.)

45°–35°: *Gradient* 1/1 and somewhat less.
A slope of this order generally looks like one of about 60° and offers very hard going if tackled directly; hands may be used to help in

ascent. Continuous turf cover will seldom be found on slopes steeper than this, and at 40° terracettes and crescentic gashes are generally well marked. Rock debris (depending on the size of block or fragment and its point of origin) progresses downward by rolling or in successive slips or at a steady creep: scree generally accumulates at an angle of about 30° and if steeper than this is quite unstable. Slopes of this steepness are difficult to utilize on account of both surface instability and shallowness of soil. They merit the description *very steep*.

25°: *Gradient* 1/2

This still presents a formidable obstacle that is walked most conveniently along a zig-zag course. There is unlikely to be any sign of terracettes provided a good vegetative cover exists, and if soil is present the forester will plant on such a slope. But the flow-off is fast and water if allowed to concentrate will produce destructive gullying. A *steep slope*.

18°: *Gradient* 1/3

This is about the maximum slope that may be found under cultivation in Britain and is then generally under permanent grass. Walking requires a definite effort and to operate a tractor and plough is difficult and somewhat hazardous. Slopes of this degree often hold hangar woods of birch, beech or scrub oak. Roads of this gradient are seldom found since 1/3 is dangerously steep for motor traffic; perhaps the most notable example in Britain is the Applecross road in Sutherlandshire. Essentially this is also a *steep slope*.

11°: *Gradient* 1/5

Careful note should be made of this angle of slope for on several accounts it is of crucial importance. It is about the limit for ground that is to be ploughed and cut annually, it constitutes a steep gradient for all modern road traffic and a troublesome obstacle for heavy commercial vehicles, and in respect of stability of site and cost of excavation it is the maximum slope that may be economically used for housing. In the case of roads and housing schemes careful provision must be made to control a fast and potentially destructive run-off of rain-water. Such a slope may be quickly recognized by the markedly stepped profile of roof-tops and gable-ends. By virtue of its influence this slope merits the description *fairly steep*.

6°: *Gradient* 1/10

Clearly noticeable and requiring some slight effort when walking, a slope of this degree is well drained and easily cultivated and built upon. It can be taken quite fast by modern cars, but heavy traffic will use a low gear and the average cyclist will walk after some little distance. A *moderate slope*.

3°: *Gradient* 1/20

Land with a slope of this order is thoroughly acceptable to farmers and builders, for drainage is good and farming and building operations are easily carried out. Extensive areas of lowland countryside in Britain fall around this category and may be described as *gently sloping*.

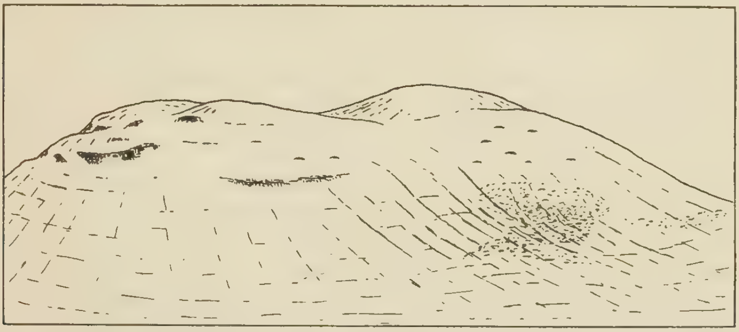

Fig. 3.—Whitewisp Hill, Ochil Hills. The following points may be noted on the above sketch in which only the dominant features and shadows are represented: a, the composite nature of the skyline; b, the crescentic gashes appearing on convex slopes of about 30 degrees; c, the face-on slopes (left centre) are of the same gradient as those viewed obliquely (right centre); d, a steep slope that is masked by a dark patch of bracken (right centre) gives the false impression of being steeper than the obliquely viewed slope immediately to the left.

Slopes of less than 3°

It is almost impossible to estimate whether ground is flat or sloping at 1° or 2°, and it may well be asked whether such a distinction is necessary at all. The answer is an affirmative if only to illustrate how small an incline can affect human activity for a gradient of 1/60 (1°) is classed as undesirably steep for steam railway operation. The best index of very slight gradients is running water: flow-off is brisk on a slope as slight as $\frac{1}{2}$°, and when less than this one may expect to find deep drainage ditches.

The relationships between slopes and flowing water comprise a topic of considerable fascination, but a vast amount of observation together with some knowledge of physics are necessary to pronounce authoritatively upon this complex matter. Nevertheless the following points may perhaps be usefully made within the scope of this article, and it is believed that they will be of stimulating interest.

First let it be noted that where water is not burdened by a load in suspension, it shows no tendency on its own account to meander until the slope is less than $\frac{1}{2}$°: the speed of flow of clear water at this angle is brisk at about 2–3 m.p.h. Meandering does of course occur on steeper gradients when it is produced by overloading and/or physical obstructions in the path of the stream. Few streams, if any at all in Britain over reaches steeper than $\frac{1}{2}$°, are carrying their full potential load except during periodic spates, and it is on just such occasions when material is being made available due to fresh incursions upon the banks by greater volumes of water that erosion is vigorous and destructive. As A. N. Strahler has remarked "nearly all important changes in the form and position of a stream channel . . . occur in relatively infrequent periods of high water." Boulders, stones and coarse gravel deposited as the aftermath of spates protect the stream-bed from erosion during periods of normal flow; if sufficiently obstructive on slopes of less than 3° they can produce incipient meanders, but on steeper gradients they merely occasion minor irregularities. Meanders (not the intrenched type) are most typically found along slopes of less than 10 minutes (gradient 1/600), and here it is interesting to note that erosional change is continuous rather than periodic; material of a relatively fine, homogeneous and unconsolidated character is readily accessible, and a process of pick-up and release is in constant operation.

On two major counts it is impossible to be precise as to the relationships between slopes and flowing water: load is a variable factor constantly affecting speed and erosional power, and secondly the stepped character of streams complicates the accurate assessment of slope. It must also be recognized that a certain pressure system exists within and along any stream course, and while this simply enough produces flooding on very low gradients, along steeper and more deeply cut upper reaches the pressure factor influences the speed of flow. Nevertheless with map interpretation in mind and to facilitate comparisons between rivers, it is useful to note certain figures that are at least of fairly general application.

On slopes of 1/5 and steeper, streams are very fast flowing and as a whole direct; at 1/3 small streams may cut so deeply as to be lost from sight, their courses being roofed over by turf. Slopes between 1/5 and 1/60 produce fast to briskly flowing water and in this context it may be noted that the first five miles of the River Tweed has an average gradient of 1/30. Long middle reaches of many rivers slope at only one half to one tenth of a degree (1/100 to 1/600) and their flow may be described as of moderate speed, i.e., 1–3 m.p.h.: some 25–30 miles of the Spey and Dee fall within this category. Gradients along the flood-plains of rivers are extraordinarily low, and while the lower 30 miles of the River Forth shows a gradient of only 1/3,000, Pardé quotes 1/20,000 for the Mississippi below Vicksburg. Rates of flow in these cases are respectively slow and very slow.

Map Interpretation

On the two Ordnance Survey map series most frequently used by geographers (1 : 63,360 and 1 : 25,000) great care has been taken in the representation of relief by means of contour lines. It naturally follows that the best possible use should be made of this effective cartographic device, but this too frequently is not the case; contour lines are often examined vaguely or used simply to ascertain isolated heights, little attempt being made to gather the information that they so readily give about the form of the landscape. It is, however, a simple matter to discover the spacings between contour lines that are representative of different slopes, and these are presented below and are invaluable in map interpretation.

	1 : 63,360	1 : 25,000
Slope	*Space between* 50 *ft. contours*	*Space between* 25 *ft. contours*
45°	Contour lines touching	Contour lines nearly touching
25°	,, ,, 1/50 in. apart	,, ,, 1/40 in. apart
11°	,, ,, 1/20 in. ,,	,, ,, 1/16 in. ,,
6°	,, ,, 1/10 in. ,,	,, ,, 1/8 in. ,,
3°	,, ,, 1/5 in. ,,	,, ,, ¼ in. ,,
1°	,, ,, ½ in. ,,	,, ,, ½ in. ,,

There is in fact little difference in the spacing between the contour lines on the two maps, but although the 1 : 25,000 permits a more precise assessment of particular slopes, the 1 : 63,360 in its generalized way yields a readier appreciation of form over an area.

Familiarity with slopes and awareness of their significance can come only through persistent field observation. In the end one's geography is improved and the pleasure of studying the countryside is greatly enhanced.

The Place of Geography in the Education of Boys and Girls of 15 to 18 Years

In March, 1956, it was announced that the Central Advisory Council (England) of the Ministry of Education was to be reconstituted "to consider, in relation to the changing social and industrial needs of our society, and the needs of its individual citizens, the education of boys and girls between 15 and 18 and in particular to consider the balance at various levels of general and specialized studies between these ages and to examine the inter-relationship of the various stages of education." In the changing circumstances of the past two decades —national and international, social, economic and educational, this is indeed a formidable no less than vital task for any Council to face. The executive committee of the Geographical Association felt, as on a previous occasion some twenty years ago (*vide Geography*, vol. 20, 1935, pp. 47–51), that it is the duty of the Association to present the case for our subject to this Council.

Accordingly, the memorandum which is published below was prepared by a subcommittee of the executive committee, and was submitted in April 1957 to the Central Advisory Council, on behalf of the members of the Association.

ALICE GARNETT
Honorary Secretary

MEMORANDUM

PREVIOUS REPORTS of Committees and Councils of the Ministry of Education [Hadow (1926), Spens (1938) and Norwood (1941)] have stressed the basic importance of Geography as being "central and indispensable in the curriculum in the grammar school" and as "a link subject between the sciences and the humanities"; and in relation to technical high schools it has been urged that the curriculum should be designed "to provide a liberal education with science and its applications as the core and inspiration . . . and with geography included as one of the subjects".

The Geographical Association, representing over 4,500 teachers of geography, expresses appreciation of the opportunity again afforded to submit evidence to the Central Advisory Council of the Ministry of Education. We ask for the continued recognition of Geography as a subject that should have prominence in the part-time and full-time education of boys and girls of 15 to 18 years, both in secondary schools and in institutions of further education, on the grounds both of its general and special values and of its particular relevance to the educational needs of the country in an era of expanding technological and technical education.

THE VALUE OF THE SUBJECT

The three main reasons why we regard Geography as an essential instrument of education for the adolescent aged 15 to 18 years are as follows:

A. *The disciplines of the subject are particularly appropriate to the intellectual needs of young people.* They call for: (i) the accurate observation of facts, not in the laboratory but out of doors; (ii) the accurate recording of these facts, especially through the medium of cartography; (iii) the integration of laboratory, library and field studies; (iv) the need for the analysis of observational data; (v) the requirement to proceed to the construction of a logical synthesis combined with the need for precision of expression; (vi) the resulting recognition of both harmony and disharmony in the use by man of his environment. (For further discussion of some of these points see "Geography in Education" in the *Geographical Journal*, vol. cxxi, June 1955.)

B. *At this relatively mature age, and for the first time in their lives, young people may obtain a properly balanced view of the world as a whole through geographical study.* In junior and middle school work much fragmentary knowledge of the world parts is acquired, but not until this later educational stage can the "whole" view satisfactorily be presented, since it must call on a wide range of fields of study and for a more mature mode of thought. Such a view should bring some realization of the extent of the world's resources, of the effects of their use and misuse; of the changing role of Britain and the specialized character of her resources; of the position of Britain and of the British Commonwealth and their associated territories in their relation to the world as a whole. These are topics that should form an essential part of any basic training in world citizenship given to older "school-leavers". Geography, therefore, should never become an alternative to another subject at the age of 13 to 14 years (as sometimes now happens) but for these older pupils should continue without break up to the age of 18, as a part of the essential basic education of the adolescent.

Courses for older secondary school-leavers, or for students attending institutes for further education, should be a challenge and inspiration for both student and teacher alike, and should open a student's mind not only to a view of the present seen in relation to the past, but also to a forward-looking view that considers the consequences and impact, on the world of tomorrow, of current trends in the use and organization of the resources of the world of today.

C. *Apart from the intrinsic values of the subject and its content, Geography "bridges" the gap between the sciences and the humanities.* The bridging value of Geography for other age groups has long been recognized (*vide* the Spens Report) but it is in the later years of schooling that the gulf between the sciences and the humanities widens seriously. The need for an effective bridge subject is therefore greater in the sixth form of grammar schools and in further education than in the earlier years. At a time when an expansion of technical and technological education is being planned throughout the country, the need to bring together the two approaches to learning at these levels makes the inclusion of Geography in science classes an invaluable corrective to over-specialization. The young student of science can gain through geographical study an insight into the humanities without being jolted too violently into something he would be apt to consider wholly alien or redundant. On the other hand, to the young student specializing in Arts subjects Geography gives opportunities to see that the humanities have scientific relationships, and to appreciate something of their relevance to the life of the world to-day.

GEOGRAPHY IN SECONDARY SCHOOLS

A. *Geography in the sixth form and upper school of grammar schools*

In the past, Geography has usually been regarded up to the age of sixteen, through the first to fifth school years, as an Arts subject and not a subject of the Science group. There is therefore greater opportunity in the sixth form for much fuller recognition of the subject as a science in its own right, requiring a scientific mode of approach and method of study. Through geographical work, in the sixth form, non-science students can become acquainted with some aspects of the precision and methods of scientific disciplines, and thereby with an important aspect of knowledge which might otherwise be missed in their school education.

We ask therefore for the provision of two kinds of geography courses in the sixth forms of all grammar schools:—

First, of courses specifically designed for those students of both the sciences and the humanities who would not otherwise read Geography, and who are specializing in other subjects. Through Geography, such students learn together something of each other's disciplines and modes of thought whilst adding to their own general knowledge. (Highly successful general sixth-form courses of this kind were instituted at Marlborough, under Sir Cyril Norwood as headmaster, as an educational experiment over twenty years ago, and they became in a few years a permanent feature of the school life.) In some cases, and as an alternative to the above, Geography could very usefully contribute as a part of a wider sixth-form general course that is concerned with a theme involving the integration of several subjects.

Second, of courses for potential specialists in Geography, with instruction at G.C.E. Advanced and Scholarship levels. Such courses would continue to meet the needs both of those who prefer to leave school for other work after completing the advanced school course in the subject, and of those who wish to continue their education at a university. The latter may read Geography for either an honours or a general degree, or as a subsidiary subject for one of the several specialist degree courses in both Arts and Pure Science of which it can form a part (e.g. biological sciences, geology, meteorology, social sciences, economics, anthropology, history, architecture, etc.).

The large and increasing number of candidates taking Geography at the Advanced level (see Appendix I) is a notable feature of post-war as well as of inter-war trends, in spite of the severe handicap—inevitable in a "young" university discipline—that at the older universities relatively few open scholarships are offered in Geography, so that many heads of schools are tempted to deflect potential university scholars towards "safer" scholarship subjects. Despite this, the subject has shown remarkable growth in sixth forms (by nine times as between 1930 and 1955, as compared with six times for physics and chemistry—see Appendix I); and the increases in the size of university departments and honours schools of geography are equally marked. The present welcome tendency towards the liberation of awards from the limitation of subject may further increase the demand for Geography at the G.C.E. Advanced and Scholarship levels.

For students trained to an advanced standard, whether at the graduate or the school level, a wide range of careers and posts other than teaching, and for which the subject has an acknowledged vocational value, is now open; moreover, from amongst those specializing in Geography in the sixth form all future teachers of the subject will ultimately be recruited.

B. *Geography in secondary modern and secondary technical schools*

(i) *Modern schools:* The appreciable numbers of pupils already remaining after the age of 15 in secondary modern schools may increase in future years.

Thirty years ago the value of Geography in such schools was stressed, and it was then urged in the Hadow report that "it should occupy no subsidiary or doubtful place, but should be one of the principal items in the curriculum". Since these words were written not only has the subject developed greatly, but many new teaching techniques and visual aids have come into use that are especially appropriate to the more practical, graphical and cartographical methods of instruction needed in these schools. With such means, valuable schemes of work can be planned to ensure that the older school-leavers from a school population of more limited abilities have learnt both within and outside school how to understand the local neighbourhood and region in which they live (and will probably work) and how to relate this to a wider region, and ultimately to the whole Homeland. Before leaving school these pupils, too, should have learnt to see their own country as an integral but highly specialized small part of the larger world-whole, in a scheme of essential general education as a preparation for citizenship.

(ii) *Technical schools:* The secondary technical schools and technical high schools, which seek to provide a secondary education for boys and girls who are practical rather than academic in bent, provide a general education using the same subjects as the grammar school, but with a bias towards their application to one or more of the broad streams of professional or vocational activity.

Geography is usually found in the curriculum of such schools, and, where work is developing towards the G.C.E. Advanced level, it usually forms a part of those courses. As in the grammar school, its value both as a cultural and scientific subject is recognized. Where a technical school develops a trend towards a vocation, Geography can contribute specialist background courses, for instance, to commerce, building or engineering. It makes a further contribution in that it can be treated as a practical subject, dealing with concrete material, and as one that appeals to the type of mind that prefers to see knowledge applied to material things. The arguments set out under section I in this memorandum are particularly applicable to the secondary technical school.

GEOGRAPHY IN INSTITUTIONS CONCERNED WITH FURTHER EDUCATION

Geography as a subject in further education can be fundamentally the same as Geography in secondary schools, and in this sphere it carries a similar or even enhanced value and importance. In further education, however, the subject must be considered in relation to somewhat different needs. Day and evening students are notoriously impatient of subjects which do not appear to improve their vocational knowledge, and employers, educational officers of firms, and principals and heads of departments of further education colleges, as well as inspectors and advisers are concerned to make sure that training time spent by these young people is used to the best advantage. The young worker, suddenly flung into an adult world, and with the stimulus of a job, rapidly becomes a person more mature in many ways than his counterpart still at school. Though he remains at heart an adolescent, he has often a revived vividness of imagination and an increased power to think logically and to concentrate. Part-time day-release education and evening class work at this stage are therefore often associated with a quickened and varied interest in the world, and Geography is well suited, through the teaching techniques that can be employed no less than through the content of the subject, to fill a real and practical adolescent need.

Part-time day-release education for the 15 to 18 year old young worker is expanding steadily. When this becomes compulsory under the County College section of the 1944 Act all such young workers will attend for one day a week. Many will take vocational courses, but there will also be many who will be receiving a general education. Geography, for the general reasons set out above, as well as for vocational reasons discussed below, has an important part to play in both general and vocational part-time day-release education for the young worker.

A survey, by the Further Education Section of this Association, of the specific place of Geography in courses of further education currently offered reveals the wide range of geographical teaching now undertaken to meet existing examination syllabus requirements, from external degree courses in Geography to retail trades junior certificates (see Appendix II). Geographical knowledge is regarded as of vocational value for many commercial posts and a number of commercial and clerical diplomas and other certificates demand the subject at various levels of study. In further education, therefore, Geography should be prominent as a subject for preliminary or intermediate level examinations, leading to posts in commerce and industry. For such posts, economic geography, which includes the study of industrial patterns and locations, and the distribution of the world's resources, markets and communications, world trade and trade routes, etc. has an obvious vocational use in many fields.

For those training for diplomas or national certificates in technical subjects (building, engineering, etc.) the subject can again have value as a science with its own disciplines, that can contribute useful background knowledge in the specialist training of technicians no less than technologists. The study, for example, of the geography of transport and communications, the location of heavy and other industries, textile manufactures, climates and atmospheric pollution in relation to industry, water resources, power resources, have relevance in such technical training.

Apart from the vocational uses of Geography, there remains its second special function, in bridging technical and non-technical education. The need for a linking subject is as great in further education as in secondary schools, but in relation to a different educational bias. Geography can help to give, better than most subjects, that "liberal education" which leaders of industry no less than of education are so rightly demanding from the technicians, scientists and technologists of the future. To meet this very urgent educational need, we ask that there shall be not only a much wider recognition of the subject's value, but also an insistence on its inclusion amongst the courses available in all institutions concerned with further education.

APPENDIX I

Numbers of candidates in England and Wales at G.C.E. Advanced level (formerly Higher School Certificate) examinations in the seven most widely studied subjects.

	1930	1955	Multiplication in the interval
English	3,539	14,204	4·01
History	3,187	11,217	3·52
French	3,703	10,878	2·94
Geography	*841*	*7,633*	*9·08*
Physics	2,860	19,609	6·86
Chemistry	2,766	16,981	6·15
Mathematics	4,048	16,670	4·12

The 1956 statistics for the Northern Universities Board show percentage increases, compared with 1955, as follows:

English, 7·7; History, 3·6; French, 2·7; *Geography*, *12·9*; Physics, 6·6; Chemistry, 6·7; Mathematics, 9·5.

(Numbers in Mathematics are doubtless higher than those given above as complications in the listing of mathematical subjects could not be analysed for the present purpose, and only the figures given under the one heading "Mathematics" have been used.)

The 1956 statistics for University of London at the Advanced level show percentage increases, compared with 1955, as follows:

Physics, 10; *Geography*, *8*; Chemistry, 7·7; Pure Mathematics, 7·2; Applied Mathematics, 10·8.

(Numbers in English, History, French and Latin declined very slightly.)

APPENDIX II

A survey of the specific place of Geography in Further Education, undertaken by the Further Education Section of the Geographical Association, investigated the prospectuses of all colleges of Further Education in England whose names were in the alphabetical group A–D. These colleges offered classes for examinations, in each case including Geography at some stage, for the following degrees, diplomas, certificates, membership of institutions, etc.

(*a*) B.Com. B.A. General B.A. Hons.
B.Sc. (Econ.) B.Sc. Special B.Sc. General
Diploma in Geography; Diploma in Economics; Diploma in Commerce
G.C.E. Advanced level; G.C.E. Ordinary level
Civil Service Executive Grade and Civil Service Clerical Grade
Local Government Examination Board
Institute of Bankers; Institute of Export; Institute of Transport
Institute of Shipping and Forwarding Agents
National Certificate of Commerce Ordinary Level and Higher Level
Purchasing Officers Association
Chartered Insurance Institute (Marine Branch)
Chamber of Shipping
Institute of Chartered Shipbrokers

National Certificate of Retail Distribution
Institute of Certificated Grocers
L.C.C. Major Establishment Grade
Royal Society of Arts Certificate
Certificate of London Chamber of Commerce
Certificate and Senior Certificate of the College of Preceptors
Institute of Meat
Police Promotion Examinations
Common Preliminary Examination of Engineering Institutions
Preliminary Examination of the Law Society
Institute of Cost and Works Accountants
Society of Certified and Corporate Accountants
Co-operative Union Examination
National Certificate in Textiles
Examination of the National Advisory Council for the Training and Education of Junior Journalists
Chartered Institute of Secretaries and Corporation of Secretaries
Retail Trades Junior Certificate

(*b*) *Many courses offered at various institutions of Further Education, but often without work for a specific examination, also include Geography, e.g.*
General commercial courses and General education courses
Pre-professional courses or examinations
Courses for Local Government employees
General courses for part-time day-release students
Courses in commercial administration
Shorthand typist courses and General clerical courses
General courses for retail trades employees

(*c*) *There are also specific courses offered as "interest courses", e.g.*
Travel Talks; Europe on your Doorstep; Geographical Study of International Problems; Social Geography; The Geography behind World Problems; Understanding the World.

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This Changing World

EDITED BY G. J. BUTLAND

HILL LAND RECLAMATION IN NORTHERN IRELAND

Ten years ago, a special scheme for ploughing and sowing rough grazing land in Northern Ireland was established when it became clear that the Hill Farming Act of 1946 could not meet the needs of many farmers. For those who could not afford a comprehensive improvement scheme this special hill land scheme could assist them to extend the arable acreage by the reclamation of land beyond the capabilities of their own machinery. Most farms in the uplands have within their boundaries patches of mixed heath or bog, commonly surrounded by cultivated fields of high productivity. These patches have been less easy to reclaim than their surroundings, or represent reversion following the slackening of pressure on the land after the mid-nineteenth century famines and prolonged emigration. Many are cut-over peat bog. During the past decade improvement has become a more attractive proposition; guaranteed markets, support prices and subsidies have stimulated the output of livestock products, while high costs for all imported fodder have emphasized the domestic value of an extra four or five acres of improved land for grazing, hay and silage. This is particularly so on farms of less than 50 acres, which means 80 per cent of Ulster's farms.

Reclamation becomes even more significant in the light of the system of land-tenure and the traditional reluctance of the Ulsterman to part with his land. Many families have farmed the same land for two centuries, formerly as tenants, but since the great estates were broken up under the Land Purchase Acts as owner-occupiers. If a man does not want to farm the land himself he lets it out in conacre for eleven months at a time by auction. Hence a thriving farm can only rarely be enlarged by purchase of neighbouring land. The progressive farmer who desires full control over his methods may find it worth reclaiming land even if the cost approaches the price which he would have to pay for additional land on the open market. There remain the deterrents of the slowness of returns in relation to a high capital outlay, and the uncertainty which attaches to any agricultural operation of a long-term kind. The decision to assist reclamation of specific fields by up to 50 per cent of the cost and to make available special machinery to undertake the work must be viewed against this background.

To be acceptable for treatment under the scheme land must appear reasonably likely to yield good crops or grass, though some very boggy areas have been treated experimentally. Although a few areas up to 1,000 feet have been reclaimed, the land is generally below the limit of economic cultivation which in Ulster averages about 700 feet. Typically the subsoil is formed of glacial gravels or clays overlying schists, basalts or sandstones, but the podsolic soils contain hard pans and are often overlain by ten or twelve inches of peat. Provided the peat is turned over and the hard pan broken up drainage is reasonably free. To treat in this way land which ordinary farm machinery could not tackle it has been necessary to introduce crawler tractors, ploughs of 1¼ tons weight, heavy disc harrows and rollers.

The tractors have specially widened tracks to give maximum efficiency on wet spongy surfaces, whilst the ploughs can be set to draw furrows up to eighteen inches deep. Transport of the machinery, which requires low-loading articulated vehicles, is a time-consuming operation and an economical plan deals with several fields in the same district successively. In the spring following ploughing the land is sown to grass with a recommended seeds mixture including rye grasses, cocksfoot, timothy and clovers. Grass is used as the pioneer crop, as drilling for deep cultivation would be difficult, especially where heather has been ploughed down. Fertility is invariably low and manure lacking, and with a grass crop, advisory officers can more easily ensure that adequate manurial treatment is given during the next two years. The soil is usually sour (about pH 4·8) and an initial dressing of 3 tons of ground limestone or 2 tons of burnt lime per acre is required, together with nitrogenous and other fertilizers. Subsequent cultivation is well within the scope of the ordinary farm equipment.

The success of the scheme under suitable conditions may be indicated by an example from the Roe valley in North Derry where one field which now carries an excellent sward and is almost indistinguishable from its neighbours, was two years ago a waste of whins and heather. On the same farm is an example of the more difficult reclamation from cut-over bog which, apart from turf fuel, had hitherto yielded only the poorest of summer grazing; this field shows signs of the return of the former dominants including rushes, *Scirpus* (deersedge) and *Sphagnum* but the owner is confident that he can turn it into good grazing land after further cultivation, liming and manuring. Another example of success in difficult conditions on the Tyrone flanks of the Sperrin Hills is a large field with a strike of good grasses cut out of the bog at 700 to 800 feet altitude six years ago. Such reclamation was once carried on laboriously by spade labour, rigging the land and planting with potatoes, a fraction of an acre at a time. Now the initial cultivations can be carried out over a large field in a few days and so far nearly 4,250 acres have been reclaimed. This is equal to only about 1 per cent of the total acreage in rotation in the two counties, but the addition to the improved acreage of individual farms is often 20 per cent or more. Initial costs total about £35 to £40 per acre of which the Ministry's contribution approximates to the cultivation work and the farmer's to the sowing and dressing. Rising charges have inevitably deterred farmers and the demand has fallen since the peak period when six sets of machinery were at work, four of them in Tyrone and two in Derry. The fall in demand for work under the scheme suggests that it will have to be discontinued if it is not extended to other counties.

(The co-operation of the officers of the Ministry of Agriculture for Northern Ireland is gratefully acknowledged.)

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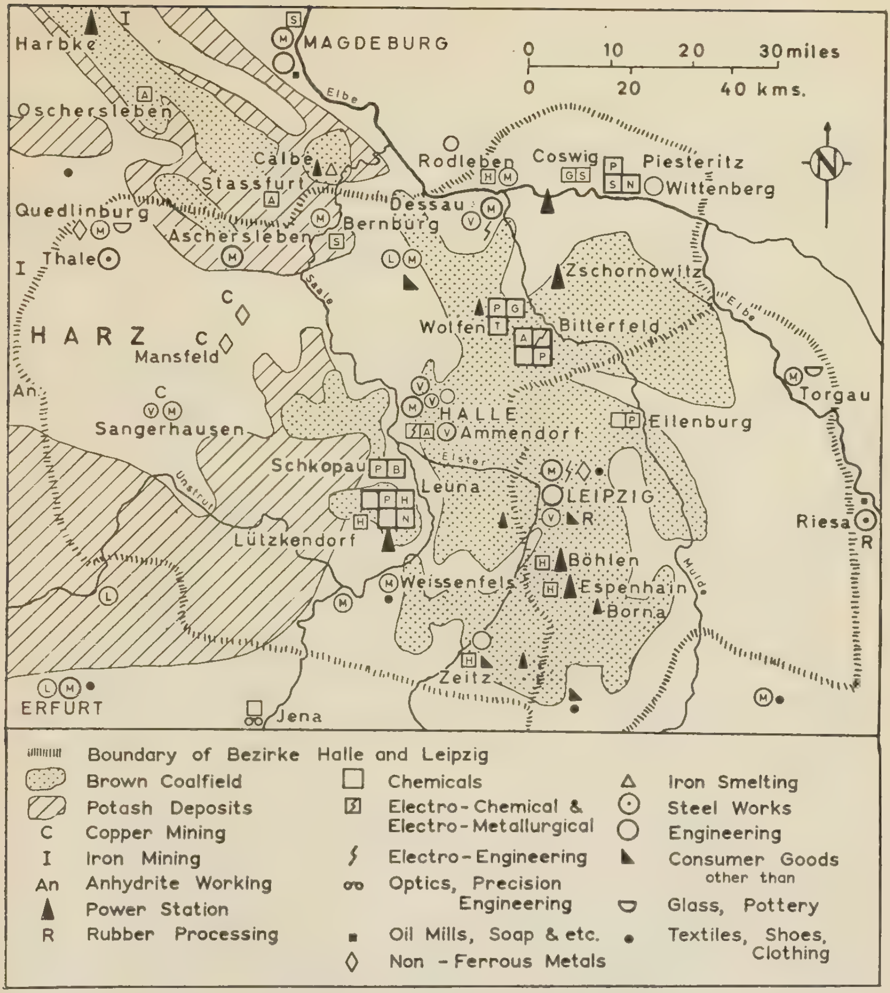
THE CENTRAL GERMAN CHEMICAL INDUSTRY

Information recently published in East German economic periodicals such as *Die Wirtschaft* and in the first statistical yearbook for East Germany (*Statistisches Jahrbuch der Deutschen Demokratischen Republik*, 1955) enables us to build up an outline of industrial developments in the Central German, or Halle-Leipzig, brown coal field. Although the predominance of this most important of all German brown coal fields in meeting East German fuel requirements is being challenged by the development of Lower Lusatia, its importance for the manufacture of chemicals remains unimpaired (*see Geography*, vol xxxvii, 1953, pp. 18–29 and "This Changing World," *Geography*, vol. xli, 1956, pp. 192–195).

In a country not well endowed with natural resources, the East German chemical industry is exceptional in being firmly based on local raw materials. The most important of these is the brown coal of the Central German field, used either directly as a raw material or indirectly as a fuel, whether for steam-raising or for generating the electricity demanded in vast quantities by the electro-chemical and electro-metallurgical processes. The Permian rocks which outcrop on the fringes of the Harz massif provide copper ores and anhydrite, both sources of sulphuric acid. The Permian also contains immense reserves of potash and common salts, preserved beneath later rocks in a broad belt surrounding the Harz. In all, the two administrative districts (*Bezirke*) of Halle and Leipzig, within which the Central German brown coal field is contained, account for 55 per cent of East German mining output by value, and 64 per cent of chemical production. Five large plants of Halle District (Leuna, Schkopau, Bitterfeld, Wolfen and Piesteritz) alone produce 45 per cent of East German chemical output, using the astonishing proportion of 32 per cent of total East German electricity output in the process. This chemical industry is of absolutely key importance to the East German economy; its home-produced plastics and aluminium replace imported iron and steel, and its synthetic rubber and fibres save imports of natural rubber, wool and cotton. In addition, chemicals are second only to machinery as an export earner.

There are three main groups of plants on the Central German field, together with some isolated works. Chemical works proper, as distinct from the hydrogenation plants producing motor fuel, are almost without exception sited on the main rivers crossing or bordering the field, the Elbe, Saale and Mulde. At such sites, works have access to brown coal or electricity generated from it and they can also obtain process water from the river and dispose of liquid effluent. The most important group, on the Saale, begins in the south with the Leuna chemical works, the largest in East Germany. In 1917 a plant was erected here for making synthetic ammonia, initially for explosives, subsequently for nitrogen fertilizer. By 1939, Leuna accounted for one-third of German nitrogen fertilizer output. To this, in 1927, was added a pioneer hydrogenation plant for making motor fuel from brown coal. The Leuna works, reconstructed after bombing and dismantling, now produce ammonia, motor fuel, synthetic glues, wood preservatives, varnishes, various drugs and disinfectants, and a range of plastics and synthetic fibres.

North of Leuna, at Schkopau is the Buna synthetic rubber plant, built just before the war. Buna is derived from acetylene, which in turn is produced from calcium carbide, made by combining lime and carbon in an electric furnace. The lime comes from quarries on the fringe of the Harz, and the carbon is supplied in the form of coke. Since the loss of the Waldenburg coalfield in Lower Silesia to Poland, coke supplies have presented difficulties, being deficient both in quantity and quality. The process consumes vast quantities of electricity, 12 per cent of all East German



Industries of the central German brown coal field. Key to individual products: Chemicals: A, alkali (soda); B, "Buna" synthetic rubber; G, sulphuric acid from anhydrite; H, hydrogenation; N, ammonia and nitrogen; P, plastics; S, fertilizers; T, synthetic fibres. Engineering: M, machine building; V, vehicle building; L, light engineering.

supplies. This is a key plant in the East German economy; not only is it the basis of synthetic rubber production, amounting to 72,000 tons in 1955, but its calcium carbide is also the starting point for a range of plastics and synthetic fibres. The Saale plants also include the Ammendorf electro-chemical works. Associated with the group are various brown coal power stations and the expanding Lutzkendorf oil refinery.

A second group of plants is found on the river Mulde in the Bitterfeld neighbourhood where the basic activity is the production of caustic soda by electrolysis. Once again, large quantities of electricity are consumed, about 3,000 kwh. for every ton of caustic soda produced. Electricity accounts for about 40 per cent of production costs, compared with 7 per cent for the raw material, rock salt. Obviously such plants will be attracted towards cheap electricity supplies, here provided from the Zschornowitz power station, based on the low-grade brown coals of this north-eastern part of the coalfield. The Bitterfeld plant is the main East German supplier of caustic soda, about two-thirds of which passes to the rayon industry. Cheap electricity is also used at Bitterfeld for the production of aluminium, while plastics of PVC type are produced. Nearby, at Wolfen, the Agfa film factory has evolved from the manufacture of photographic chemicals and films to the making of plastics, rayon, perlon and other synthetic fibres. There is also a large plant, built in the 1930s, for the manufacture of sulphuric acid from East German anhydrite.

The last of the three main groups is located on the east-west course of the Elbe, on the northern fringe of the field, where the plants are well placed to draw on imported raw materials like phosphate rock for fertilizer manufacture. Piesteritz makes nitrogen and phosphorous fertilizers, and some plastics; new calcium carbide capacity and a balanced fertilizer plant have recently been installed. Downstream at Coswig is a superphosphate plant. To save imports, the necessary sulphuric acid is now made in an adjoining plant from anhydrite mined on the southern flank of the Harz. An extension to this plant to make 140,000 tons of acid and 150,000 tons of by-product cement each year, should come into operation in 1959. In this group is also the Rodleben hydrogenation plant.

Among the more scattered works may be included the hydrogenation plants of the southern part of the field which in addition to motor fuel, provide various important by-product materials, including phenols for the plastics industry. Other isolated plants are the Eilenburg celluloid and plastics plant on the Mulde, and the soda plants at Bernburg and Stassfurt in the northwest.

The East German chemical industry was hard hit by war-time bombing and post-war dismantling. It is reported that losses amounted to 80 per cent of soda capacity including all of the Bernburg plant, 60 per cent of sulphuric acid capacity, 50 per cent of its calcium carbide, and nearly all the phosphorus plant at Piesteritz. In addition, the power plants supplying the industry were reduced to less than one-third of their peak war-time capacity. By 1955 output of the main chemical products had been raised by anything from 20 to 200 per cent above pre-war figures, and output was generally above the peak war-time levels. In the post-war circumstances of industrial dislocation and shortage of vital imports, this is an impressive achievement.

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THE SUEZ CANAL 1935–55

What is the present significance of the Suez Canal in the pattern of world trade? An examination of the relevant statistics indicates that at the time of its nationalization the Canal was of far greater importance than ever before in its history. It is not generally realized how remarkable has been the increase in the amount of trade and traffic passing through the Canal during the last two decades. The total net tonnage for 1955 was approximately four times the annual average for the nineteen-thirties, an increase that previously had taken forty years to accomplish. This development is shown in Fig. 1, which also indicates how well the Canal traffic mirrors the economic state of the world. The wars, the Great Depression, the Abadan oil crisis, and much else, are all recorded in the sinuosities of the graph. Thus it is to be expected that both the number of vessels using the Canal, and their size, is far greater to-day than before the war. In 1935, 5,992 vessels passed through the waterway: in 1955 the number was 14,666. The average gross tonnage per ship in 1935 was 7,695, but in 1955 it had risen to 10,542. In 1935 almost two-fifths of the vessels were between 6,000 and 8,000 tons, but in 1955 only one-sixth were of this size, the largest group (24 per cent) being between 10,000 and 12,000 tons.

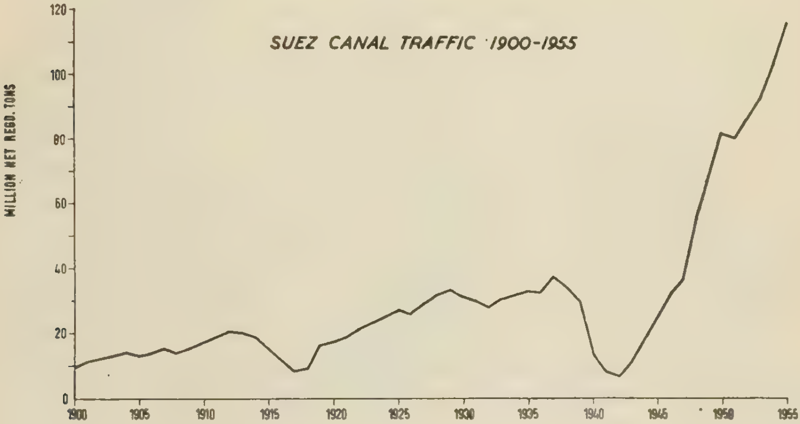


Fig. 1.

These developments are a reflection of the growing reliance of Western Europe upon oil from the Persian Gulf area; a trade that has grown almost entirely since the war. This is a one-way traffic (tankers returning in ballast), and has made the disparity between northbound and southbound trade through the Canal even more marked. Northbound traffic consists mainly of bulk foodstuffs, raw materials and mineral ores and has always been greater in weight than the southbound traffic, which consists principally of machinery, manufactured articles and fertilizers (Fig. 2). Each year before the war twice as much merchandise moved north through the Canal than moved south, but the northbound traffic has now become four times that of the southbound, although the southbound cargo tonnage has increased from 8·1 million to 20 million tons. The extent to which this is due to increase in northbound oil cargoes may be seen from the fact that from an annual average of 4·5 million tons during the nineteen-thirties, 67 million tons went through the Canal in 1955. During the earlier period oil accounted for 24 per cent of northbound cargoes by weight: in 1955 this had risen to 76·5 per cent; and in 1955 approximately 3 vessels out of every 5 using the Canal were oil tankers.

Coal no longer figures as a major southbound cargo, a decline that became noticeable after 1930, reflecting both Britain's changing situation as the world's premier coal exporter, and the decline of coal-fired shipping resulting in decreasing demand for bunker coal. It is surprising to discover that in the decade since 1946 coal cargoes passing through the Canal from the south (from India and South Africa) have exceeded those from the north by 1½ million tons. The decline in the bunker trade may be deduced from an analysis of the motive power of the Canal shipping: in 1935, 2,829 ships passing through were coal-fired, 1,621 were oil-fired, and there were 1,542 motor ships. In 1955 only 89 such vessels were coal-burning, 6,971 oil-fired, and 7,602 were motor ships. Like the old sailing vessels, coal-fired ships will soon be things of the past.

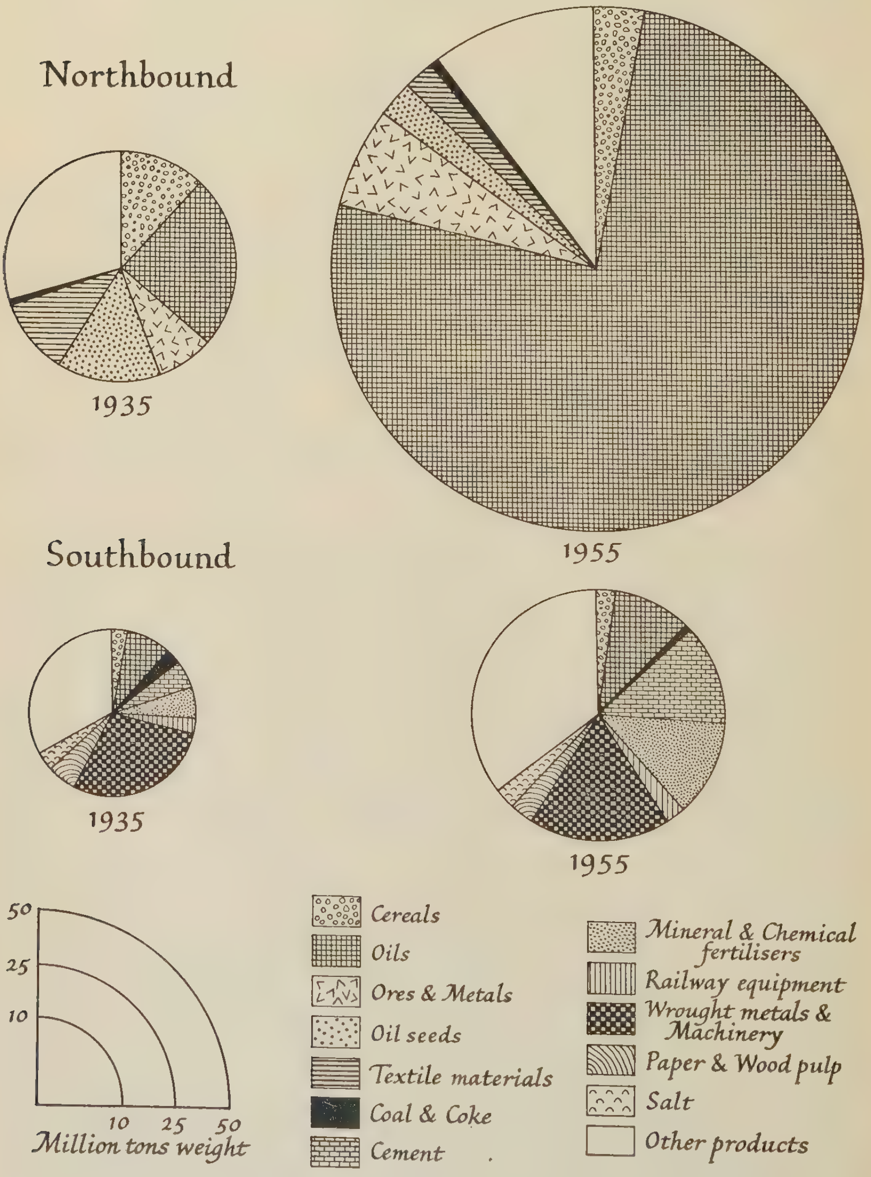


Fig. 2.—Composition of trade through the Suez Canal, 1935 and 1955. (Drawn at the office of the Royal Geographical Society.

The break-up of the Italian Empire in East Africa helps to account for a decline in trade from and to the area nearest the Canal since 1935, but for all other areas south and east of the Canal trade has increased. However, as Fig. 3 shows, the order of importance of the various parts of this "hinterland" has changed markedly. The bulk of the early trade through the Canal came from the British Indian Empire and the Far East. To-day, with its heavy oil shipments the Persian Gulf is the source of two-thirds of traffic, whereas the former Indian Empire area, despite a modest increase in amount, now accounts for a mere 8 per cent of the total. Europe was the destination for 85 per cent of the northbound trade.

In the first decade of the Canal, British shipping exercised a virtual monopoly, four out of every five vessels in transit being British. The development of merchant navies of other powers has led to a decline in the share of Canal traffic under the British flag. In 1935 48 per cent of the net tonnage in transit was British, the nearest rival being Italy with 18 per cent. Since 1945 the proportion of shipping using the Canal under the British flag has declined sharply, for increases in the number of British vessels and in net registered tonnage have been slight, relative to those of other flags. Here also is to be found a reflection of the growing use of flags of convenience to avoid heavy taxation in a number of European states, especially Great Britain. This has

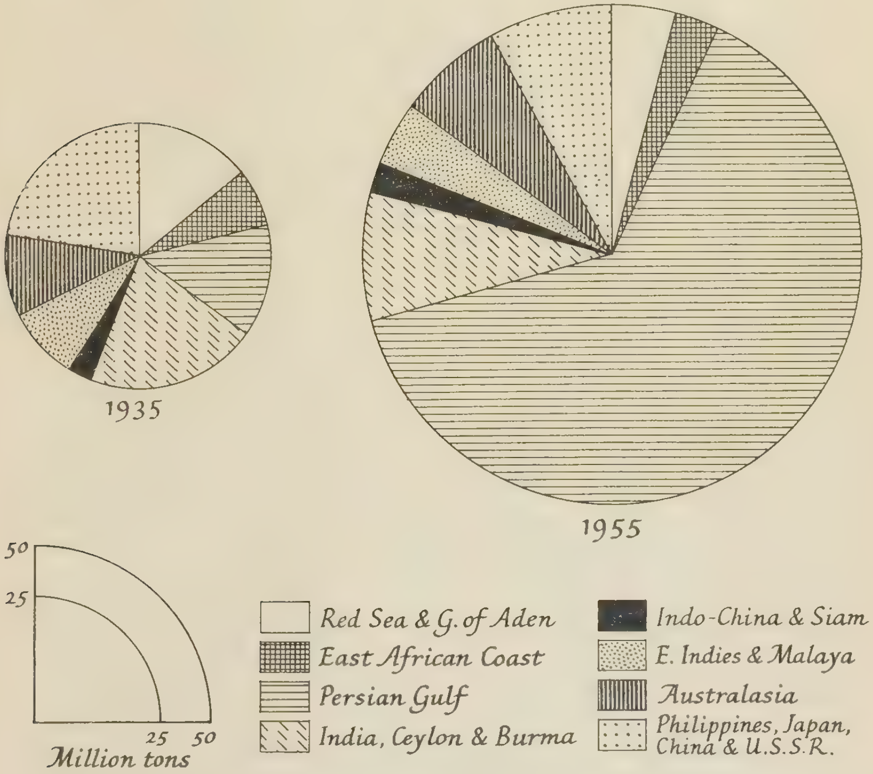


Fig. 3.—Trading areas south and east of the Suez Canal, 1935 and 1955. (Drawn at the office of the Royal Geographical Society).

led to a notable rise in the proportion of vessels passing through the Canal flying the flags of Liberia and Panama. In 1955 only 28 per cent of the net tonnage in transit was under the British flag.

The increasing trade and importance of the Canal have been mirrored in the increasing development and prosperity of its chief port, Port Said. In terms of the volume of international shipping using the harbour and facilities Port Said is one of the principal ports of the world, being well ahead of London, New York and Rotterdam. From about 6,500 vessels of fifty million gross tons in 1935 the number entering the port had increased to 15,654 in 1955, with a gross tonnage of 157,829,000. Of these ships, however, no less than 14,823 were coming through or arriving at the Canal: this serves to emphasize the principal function of Port Said as being a port of call where most ships take on bunkers, water and supplies. Their stay in the port is generally brief.

The spectacular increase in oil cargoes in the last decade has meant, in fact, that traffic has practically overtaken Canal enlargements and improvements. By the end of 1955 (when approximately 50 per cent of Europe's oil came via this route) the waterway was being utilized almost to its capacity. It was with a sense of urgency that the Eight Year Development Programme was begun that year, its aim being to make possible an annual transit of 18,000 ships and the northward movement of over 100 million tons of oil by 1960. The constant development of the Canal ahead of mercantile demands was a firm policy of the Suez Canal Company, and neglect of this aspect may be one of the most serious consequences of the recent changes.

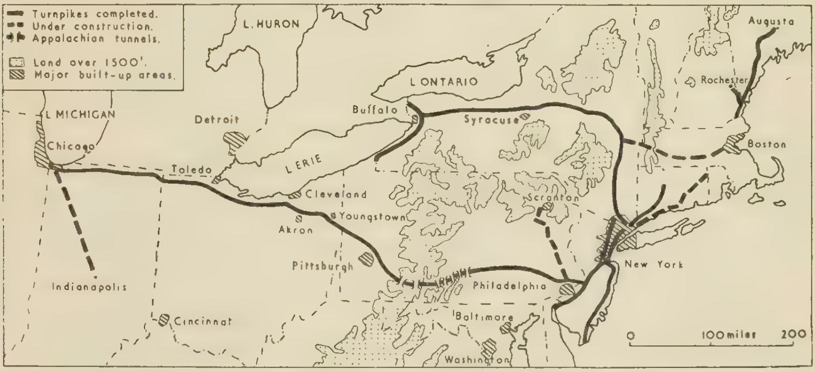
Bedford College, University of London. ALAN B. MOUNTJOY.

STATE TURNPIKES IN THE NORTHEASTERN U.S.A.

Current speculation about new types of roads in Britain inevitably fosters comparisons with the road-making efforts of the United States. There, an attempt is being made to cope with 75 million motor vehicles and to check a national road death rate of 40,000 a year, in part by building very fast but safe toll-roads. Short sections exist in West Virginia, Florida, Oklahoma and Colorado; but they are mainly confined to the northeast, where nine states are constructing or are already using 2,000 miles of four-to-eight-lane turnpikes. A spectacular number of safety devices is incorporated in their design. Each turnpike is set in a very wide right-of-way; the dual carriageways are divided by a central mall, often tree-planted to screen the opposing traffic streams; and twin bridges are provided at overpasses. Something like 30 acres are needed for each mile of turnpike, and land acquisition has sometimes been a considerable problem. Moreover, the rapid construction of these roads could be achieved only through the use of large labour forces and giant roadbuilding equipment, for all except the most gradual slopes and curves have been eliminated by using cut-and-fill methods.

These concrete and steel roads are limited-access highways. They make their few junctions with other main roads by means of cloverleaf interchanges, usually on the outskirts of the towns near, rather than through, which the turnpikes pass. The motorist is thus unhindered by any stop lights or cross-traffic. Experience shows that about an hour may be saved in a trip of

75 miles by using the toll roads, for there is every incentive to maintain the legal maximum speed of 60 or 70 m.p.h. Sustained speeds of this magnitude may be tiring, producing turnpike hypnosis in the more monotonous landscapes where even the familiar billboard is banned; consequently restaurants and service stations are provided every fifteen miles or so.



Such immense undertakings have proved very expensive for the individual states to build at nearly 2 million dollars a mile in open country and up to 10 million in urban areas, yet public funds have almost never been made available, and the money is raised by means of revenue bond issues. The turnpikes must be self-paying, and indeed self-redeeming, since they are expected to pass eventually into the state road systems as free-ways. The tolls levied are not inconsiderable, especially for goods vehicles, but on the whole the volume of traffic attracted to them has been up to expectations. The toll is considered well spent in reducing fuel consumption and maintenance costs and in permitting speedy and smooth transport links.

The concept of the modern turnpike originated in the Great Depression, partly to reduce unemployment. It was put into effect, with support from the federal government, in Pennsylvania sixteen years ago as a highway tunnelling the Appalachian ridges from Pittsburgh almost to the east coast. Other states were slow to follow the example, even though the transport revolution in which the motor truck has taken over perishable cargoes from the railroad freight-car was well advanced. In the late 1940's, however, the movement began to gain momentum, not to provide work but to establish trunk routes superior even to the proven excellence of the Penna Pike; and to-day the turnpikes are becoming linked and a network is beginning to appear. A continuous line is open from New York to Chicago, following the Pennsylvania Railroad. Another links New York City and the upstate industries along the historic Hudson-Mohawk route. A third will thread industrial New England between New York and Boston. Feeder-lines are being extended into northern New England, the Pennsylvanian anthracite coalfield and the heart of Indiana. The belt of densest industry and population is thus being served, with the New York–Philadelphia fall-line as the axis.

On the whole, these turnpikes are lowland routeways, apart from stretches across the Appalachians, the Berkshires and the Catskills. The mountain and the urban sections were often difficult to engineer; but the lowlands also presented such special problems as bridging wide rivers like the Hudson, or relocating streams and canals to make room for the highway. In areas of intensive glaciation, boulders in the Midwest glacial till complicated the driving of steel piles; the bed of Quaternary Lake Maumee had to be made flood-proof; glacially-scoured bedrock surfaces in Massachusetts required investigation by means of a seismic survey. Peatbogs and mud swamps 250 feet deep have been dried out, in Ohio, by dumping immense quantities of sand at one edge to squeeze out the slime; in New Jersey by sinking sand drains; and in New York by replacing the swamp deposit with more satisfactory material. These changes have had substantial effects on the physical landscape.

In economic and social aspects, too, the turnpike development has already had a far-reaching influence, sometimes adverse in a rather direct way. There have been dislocations and demolitions in existing settlements; Fultonville in the Mohawk Valley and other towns have been split in two by a swathe hundreds of feet wide. On the other hand, the benefits of quicker and cheaper transport have accrued to many farmers and to those concerned with tourism. Dairying and poultry farming, fruit growing and market gardening are beginning to develop in the more remote countryside, away from their traditional location on the urban fringe; and the rugged lands of the Canadian border and of inner Appalachia are sprouting new vacation facilities. The most striking result, however, has been the way in which the turnpike interchanges have become focal points for contemporary residence, commerce and industry. In their vicinity housing estates and super-markets have sprung up, as have transport terminals on the outskirts of industrial towns. Industries which rely on fast transport or on only small quantities of raw materials have been greatly attracted to these foci, and industrial parks (embracing factories for, to name a few, electronic, plastic, metal-working and food products) have been laid out beside suitable interchanges, for example north of Syracuse. New patterns of trucking, of motor travel and of suburban living are taking shape.

The turnpikes themselves generate a great deal of new travelling. The traffic on them is basically short-trip in character, and they are used for running into town, even if the town happens to be fifty miles away. This traffic must still get down-town after it has been disgorged from the turnpike, to add to the congestion of the ordinary city streets. In contrast to the speed-up of movement between towns for travellers and goods the delays in distribution through urban clogging have become more pronounced. Yet despite such disadvantages, many authorities believe that the existing turnpikes will prove successful, and that within the next ten years a true network will emerge. It is probable that this network, if it materializes, will remain virtually confined to the north-eastern states, where one third of United States industry is concentrated; and where an express lorry route from Chicago to Boston would parallel and supplement the St. Lawrence Seaway. In time to come the megalopolis which seems destined to spread from Portland (Me.) to Washington D.C. will have express-ways for its main street: whether they are toll roads or free-ways will depend largely on the outcome of impending congressional discussion over federal funds for road-building.

University of Reading. P. D. Wood.

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LONGMANS

programmes that individuals, who are not at present branch members and who would like to participate in activities, may feel that their interests are being cared for, the following area divisions were made:

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These divisions have been based on transport facilities and existing branch relationships. Members in these localities who would like to receive branch programmes should write to the secretary of the appropriate branch. New branch organization is needed in *Luton* (Harpenden, Dunstable, Bedford), *Bletchley* or *Northampton*, *Guildford* (west Surrey) and *Redhill* (central Surrey). Members willing to help to start branches in any of these districts are asked to write to the Assistant Secretary who can supply the names of other members in the same locality and information about branch organization.

Yet another area of branch development is in the northeast where there are now two active branches. Support is needed from members in the Newcastle district and Northumberland for the *Newcastle Branch*, details of whose summer and winter programme may be obtained from Mr. S. L. Hockey, 12 Leazes Terrace, Newcastle-on-Tyne. The secretary of the *Tees-side Branch*, Mr. K. R. Stott, c/o Stockton Grammar School, Stockton-on-Tees, seeks the support of members in the area served by the branch, which usually meets at Stockton-on-Tees, and whose area includes Durham, Northallerton, Barnard Castle and Richmond. The winter programme is already being announced.

OVERSEA GROUP OF G.A. MEMBERS

Thanks to the enthusiasm of a nucleus of members in Jamaica a group of full members of the Association has formed an oversea branch there, with the intention of promoting closer contacts amongst geographers on the island and stimulating interest in new developments in the subject.

ANNUAL SUBSCRIPTIONS

Annual subscriptions are due for renewal on 1st September for the following year to 31st August, 1958. This applies to full members (£1 1s. subscription), student members (10s.) and schools and colleges which subscribe at the special rate of £2 2s. for extra library facilities. Prompt payment, using the renewal form enclosed with this issue, will assist revision work on headquarters records.

LIFE MEMBERS' RECORDS

In order to eliminate errors and discrepancies in headquarters records a letter was sent to all Life Members in June this year, requesting a written confirmation by 31st August of the address to which *Geography* is sent. As it was explained in the letter, the absence of a reply by 31st August will be taken to mean that the Life Member no longer wishes to receive *Geography* and no issue will be sent after July. Life Members who have not already returned the acknowledgement slip are advised to do so without delay to prevent cancellation of records.

CHANGES OF ADDRESS

All members are requested to inform headquarters office as early as possible when they change their address or discover errors in addresses stamped on the envelope or wrapper of *Geography*. Notification of changes and errors will help to eliminate non-delivery of journals and will save the expense of replacement copies.

HEADQUARTERS STAFF

Miss Joan Higgins, who joined the Association's staff as a clerk shortly after the office was removed to Sheffield in 1950, and known to many members who have attended Annual Conferences in recent years, was married on 8th June to Mr. William Felkin. Wishing Mr. and Mrs. Felkin much happiness, the Association has presented them with two chairs. Mrs. Felkin is to continue her service as the Association's senior clerk.

O.S. WATER AND CONTOUR PULLS

A few maps showing water and contours only have become surplus to orders under the Association's special arrangement for obtaining these pulls from the Ordnance Survey for members. One copy only of each of the following sheets is in stock; applications to purchase should be made to the Assistant Secretary, accompanied by postal order in remittance. To the total cost of the maps on each order add 1s. 6d. to cover postage and packing.

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SO/85 Worcester
SU/99 Amersham
SV/81 Scilly Isles, W. of Tresco
NX/92 Workington (and southwards)
NY/32 Blencathra (and southwards)
TM/26 Framlingham

A NEW TOURIST MAP

A new publication of the One-inch Tourist Map of the Peak District was announced by the Ordnance Survey Office for publication in July 1957; it is in the Seventh Series style with the addition of layer tints and hill-shading.

Reviews of Books

With very rare exceptions, books reviewed in this journal may be borrowed from the Library by full members or student library members of the Association.

The Granite Controversy. H. H. Read. 14 × 22 cm. xix + 430 pp. London: George Allen and Unwin Ltd. 1957. 42s.

The Granite Controversy consists of eight presidential addresses and special lectures devoted to the problem associated with the nature and origin of granites, together with a bibliography of over 400 references and a useful index. Professor Read's review of granites is authoritative because he has followed his own advice and spent many years looking at the rocks. He has also multiplied his own powers of observation by directing the researches of many others engaged upon the granite problem; this is necessary since granites and related rocks constitute such a vast part of the make-up of continental regions.

The granite controversy is strictly concerned with the rival claims of those who regard granites as products of crystallized melts (the "magmatists") on the one hand, and those favouring an origin by the metamorphic transformation of pre-existing solid rocks (the "transformists") on the other. Professor Read has sometimes been accused of bias in favour of the latter; but in fact probably no one has done more to demonstrate that granites are of diverse kinds and origins and that both views are right when applied to the proper crustal environment. The very comprehensive review takes into account many problems of regional metamorphism, such as the origin of schistosity and the significance of metamorphic zones and facies. The inseparability of granite and regional metamorphic rocks is one of Professor Read's main theses and constitutes the subject matter of two of the addresses. Another dominant theme is that of the Granite Series (Read) with its emphasis upon the importance of the setting of granite phenomena in place (in relation to depth in the earth's crust, for instance) and time (in relation to orogenic and metamorphic episodes). This is perhaps the most significant single contribution of the addresses. In the past much effort has been misdirected into attempting to prove granitization (i.e. transformation) in relation to granite bodies placed high in the crust and late in orogenic cycles where the granites are demonstrably in the wrong environment for granitization. Conversely magmatists have sometimes tried to ignore the compelling field evidence of basement complexes and orogenic root zones which provide the proper environment of granitization. Professor Read has provided the means of reconciling the conflicting views.

This is not a text book, and it suffers from some defects inherent in collected writings. Professor Read's style, however, is effective and highly individualistic, which is part of the appeal that the book should have for all readers—particularly geographers and geologists—who have the necessary background knowledge and an interest in the rocks which form the foundations of the continents. Under Professor Read's guidance these rocks assume a more lively character than they appeared to possess before.

M. K. W.

Pioneer Peasant Colonization in Ceylon. A study in Asian Agrarian Problems. B. H. Farmer. 14 × 22 cm. xxvii + 387 pp. Issued under the auspices of the Royal Institute of International Affairs. London: Oxford University Press. 1957. 55s.

The island of Ceylon has sometimes been picturesquely described as "The Pearl of the Indian Ocean", but to many British servicemen who were stationed there during the 1939–45 War it possessed another, equally picturesque, but much less complimentary description. Though Mr. Farmer was one of those stationed on the island for some time during the war, he obviously did not share the usual serviceman's view: his geographical interest was aroused, and eventually he was able to revisit the island for several months in the latter part of 1951 and, while completing the writing of this book, he was invited by the Government of Ceylon to serve on a commission to investigate land policy. He is thus well equipped, from his own first-hand knowledge, for the task he has set himself.

The book itself is divided into three parts. The first part, slightly more than a quarter of the whole, forms a general introduction in which, perhaps inevitably, the emphasis is on various aspects of the geography of the Dry Zone. This is followed by an account of the evolution of a policy of peasant colonization. The third and major part is concerned with various aspects of the problems of the present day colonization schemes, such as irrigation and land development, selection of colonists, diseases and water-supply, and social factors. Numerous tables within the text increase the already very considerable amount of detail to be found in this work which is also commendably fully documented. The maps are adequate but the photographs might, with advantage, have been clearer. A useful glossary (mainly of Sinhalese words) and a comprehensive index complete the book.

To many geographers, the first and more general part of this book may well appeal most, but to all who are interested more particularly in agrarian problems and the colonization of underdeveloped tropical lands the whole will be invaluable. This most important account is surely likely to remain a standard work on this subject for many years to come. I. S. M.

Asia. A regional and economic geography. 9th edition. L. Dudley Stamp. 14 × 22 cm. xvii + 726 pp. London: Methuen and Co. Ltd. 1957. 55s.

Southeast Asia. 5th edition. E. H. G. Dobby. 14 × 21.5 cm. 415 pp. University of London Press Ltd. 1956. 18s.

The latest edition of Professor Stamp's well-known book on Asia retains many of the features of the earlier ones but the revision has this time been much more drastic, making it more up-to-date than some of the earlier revisions ever were. The information for some areas has been greatly expanded—Cyprus is now given six pages and four maps—while separate accounts of others are introduced for the first time—the former French settlements in India which, as the text states, ceased to exist as such in 1954. The inclusion of up-to-date statistics adds to the value of this edition. There are, however, a few errors that need correcting: for example, in the table on p. 424 Kuala Lumpur is shown as the capital of Singapore and in footnote 1 on p. 659 " west " should be "east".

The publication of a new edition of Professor Dobby's book has also resulted in some revision. Statistics have been brought up-to-date as far as possible and some short passages have been rewritten. But there seems to have been very little attempt to remedy the major defects in this work that were noted in the review of the first edition (*Geography*, vol. xxxvi, 1951, pp. 212–3). In particular, the work has many badly composed passages. Though some errors of fact have been corrected, others have crept in, as in the new section on the political development of Indo-China where "Indochina" should be "Cochin-China". A short new section has now been added at the end of the second chapter on Java entitled "The Postwar Phase". A much more comprehensive revision of this text would enable the book to achieve the standing of which it is potentially capable. I. S. M.

China's Changing Map. T. Shabad. 15 × 23.5 cm. x + 295 pp. London: Methuen and Co. Ltd. 1953. 32s. 6d.

Both in approach and content this new book corresponds with the earlier volume by the same author on the U.S.S.R. It has very much the same advantages and defects and an excellent appraisal of these will be found in a review of the *Geography of the U.S.S.R.* in *Geography*, vol. xxxvii, 1952, p. 119. As a source of factual information, laboriously compiled from scattered sources, the book is extremely useful, although it should be noted that nowhere does Mr. Shabad attempt any assessment of the accuracy of the figures he has used. On the other hand, the book is subtitled "A Political and Economic Geography", and it is in this direction that Mr. Shabad's limitations appear. Each part of the book has a short introduction on the physical geography of the area described and this duty done, the remaining information in each section is arranged in a uniform sequence that makes the book uncommonly monotonous to read. Throughout, facts are presented without comment and the book is best read with reference books at hand to help in the assessment of the significance of such diverse information as the production of 15,000 tractors of 54 horsepower, 86,258 tons of cotton, 260,000 hectares of cotton (a different province, no figure given for production), 13,000 tons of antimony, 1,200 kilograms of gold, 10,000 tons of cassia oil and so on. To Mr. Shabad text-book maps have only one function, to locate the towns he names in the text; that they might be effectively used to convey other information is accepted here no more than in his earlier book. With adequate maps showing both the facts that he has collected for this book and some of the relevant relief or climatological information, this book could serve well as an up-to-date economic geography of China; in its present form it must necessarily be consulted for the information it contains, but it cannot be recommended on any other grounds. K. M. C.

Atlas of the World's Resources. Vol. I. The Agricultural Resources of the World. William van Royen. 35.5 × 31 cm. vi + 258 pp. London: Constable and Company Limited. 84s.

This volume appeared in the U.S.A. two years before its publication in Britain. It is otherwise as up-to-date as any such work can be and gives an admirable survey of world agriculture at about 1949. Commodities are treated according to their importance. Thus two maps are given to bananas, but no less than 29 to wheat, including maps to show the origin of wheat species, marketing channels in the U..S.A and isochrones for seeding and harvest as well as area and dot maps. The text is very full and roughly proportional to the number of maps. There is also an introductory section with land-use and other maps. The atlas is of manageable size though larger and more detailed than other economic atlases which have appeared recently and should make a valuable reference work for library use.

A. J. H.

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Listed from Periodicals received in the Library

CONTINUED FROM VOL. XLII, PP. 133 TO 136.

Journals listed here may be borrowed from the Library by members of the Association. References are listed according to the classification published in the *Annals of the Association of American Geographers*, vol. xxvii, June 1937. Authors' reprints presented to the Library are included in the list of articles.

A—Australian Geographer. AG—Acta Geographica. A of G—Annals of the Association of American Geographers. EG—Economic Geography. FO—Focus. GJ—Geographical Journal. GR—Geographical Review. GRI—Geographical Review of India. GS—Geographical Studies. IBG.—Papers of the Institute of British Geographers. J of G—Journal of Geography. LS (H)—Lund Studies (Human). LS(P)—Lund Studies (Physical). MJTG.—Malayan Journal of Tropical Geography. NG—New Zealand Geographer. OG—Oriental Geographer. PGA—Proceedings of the Geologists' Association. SGM—Scottish Geographical Magazine.
*—Maps.

PHYSICAL AND CLIMATIC GEOGRAPHY. P. R. CROWE, GS, No. 1, '57.—Further thoughts on evapotranspiration: a new estimate. I. HUSTICH, AG, vol. 15, '56.—Correlation of tree-ring chronologies of Alaska, Labrador and northern Europe. G. MANLEY, SGM, Apr. '57.—Climatic fluctuations and fuel requirements. C. O. SAUER, GR, Jan. '57.—End of the ice-age and its witnesses. J. A. STEERS, IBG, '56.—Coast as a field for geographical research. H. SVENSSON, LS(P), No. 8, '56.—Method for exact characterizing of denudation surfaces, especially peneplains, as to the position in space. P. J. WILLIAMS, GJ, Mar. '57.—Investigations into solifluction features in Norway.

CULTURAL AND ECONOMIC GEOGRAPHY. S. GODLUND, LS(H), No. 18,'56.—Function and growth of bus traffic within the sphere of urban influence. S. GODLUND, LS(H), No. 17, '56.—Bus service in Sweden. H. J. NELSON, EG, Apr. '57.—Characteristics of the population of cities in similar service classifications. P. H. SISCO, J of G, May, '57.—Geographic training and method applied to trade analysis of local shopping centres. C. WAGNER, J. of G, Mar. '57.—Planned industrial districts. L. ZOBLER, A of G, Mar. '57.—Statistical testing of regional boundaries.

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